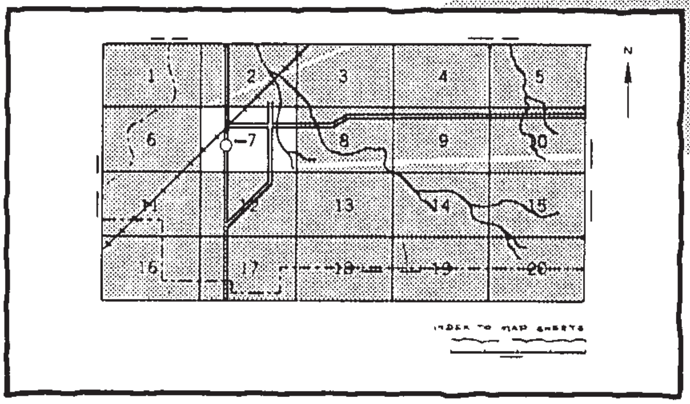
SOIL SURVEY OF
Nowata County, Oklahoma

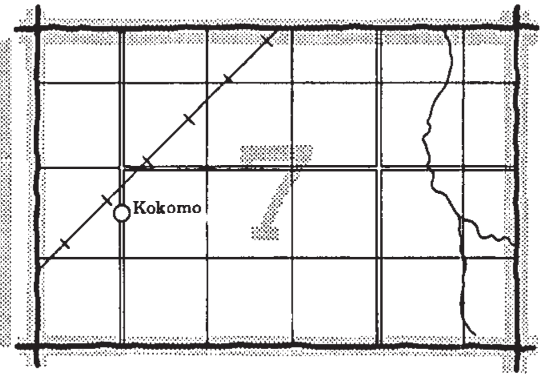
United States Department of Agriculture
Soil Conservation Service

in cooperation with
Oklahoma Agricultural Experiment Station

HOW TO USE

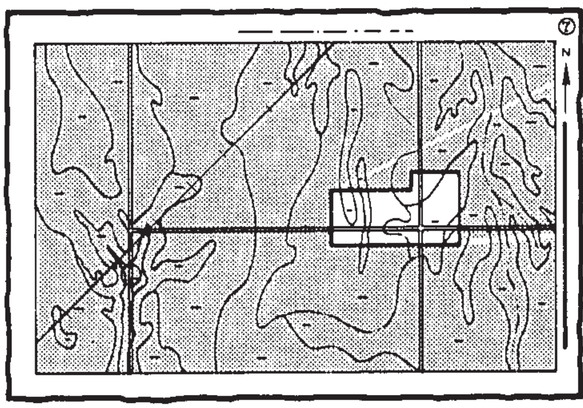
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

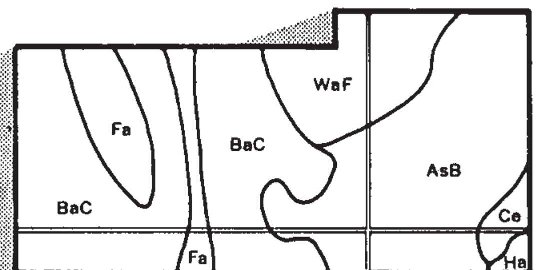




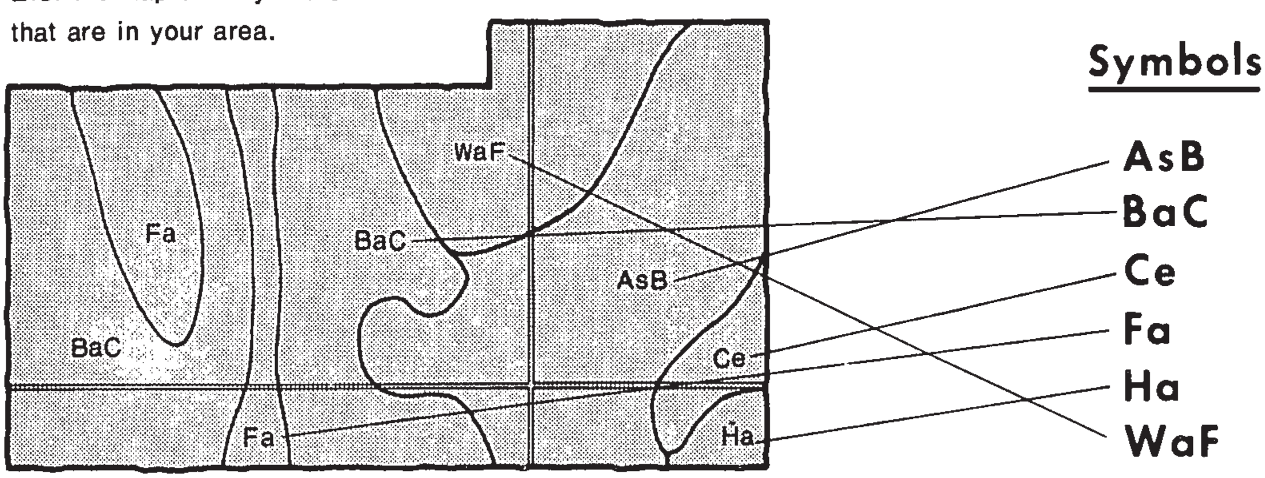
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



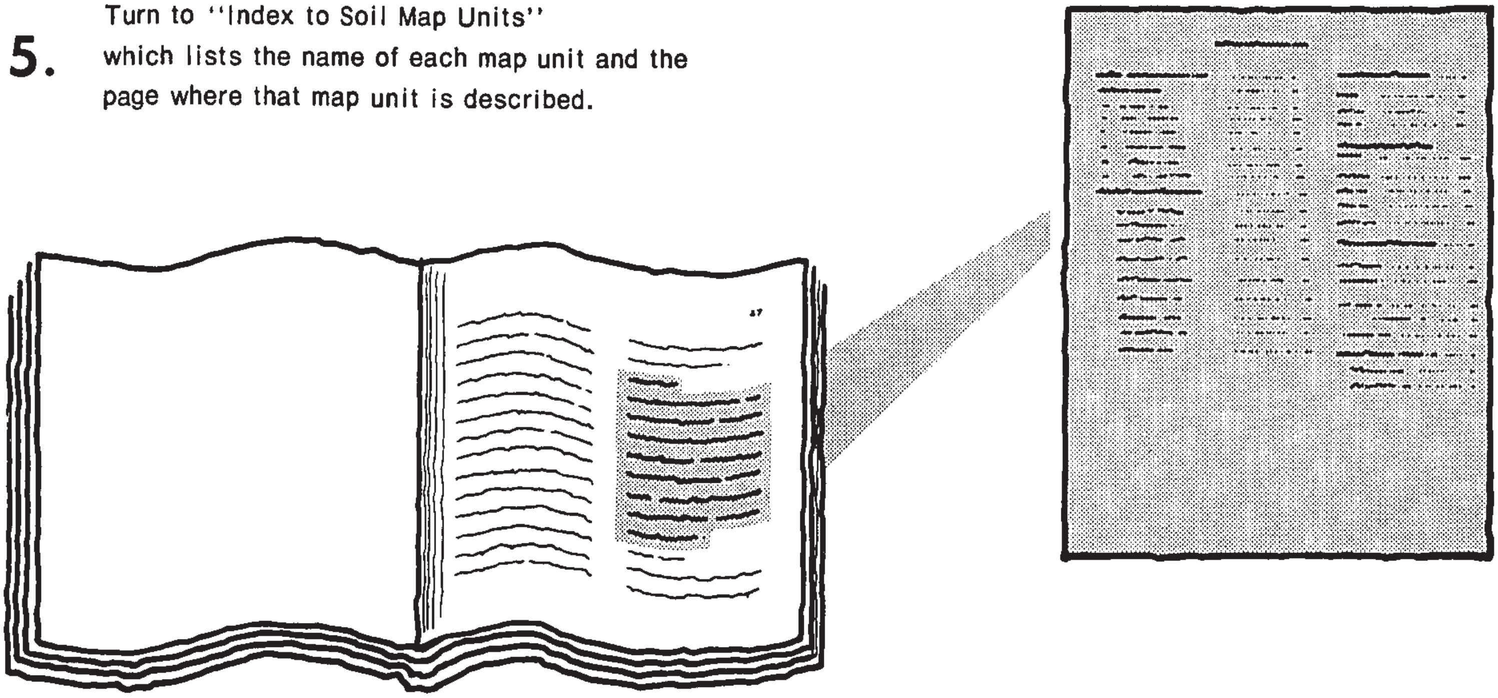


4. List the map unit symbols that are in your area.

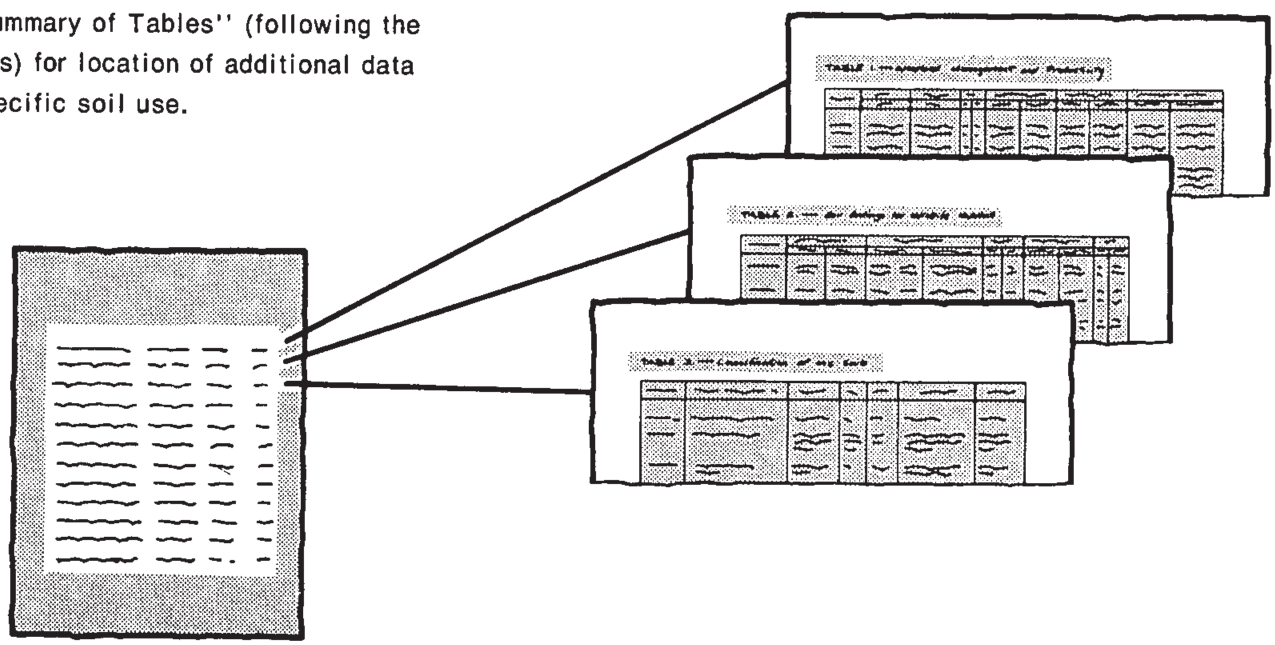


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was done in the period 1961 to 1975. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Nowata County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

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Issued June 1979

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Summary of tables

Foreword

This Soil Survey contains much information useful in land-planning programs in Nowata County. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Roland R. Willis

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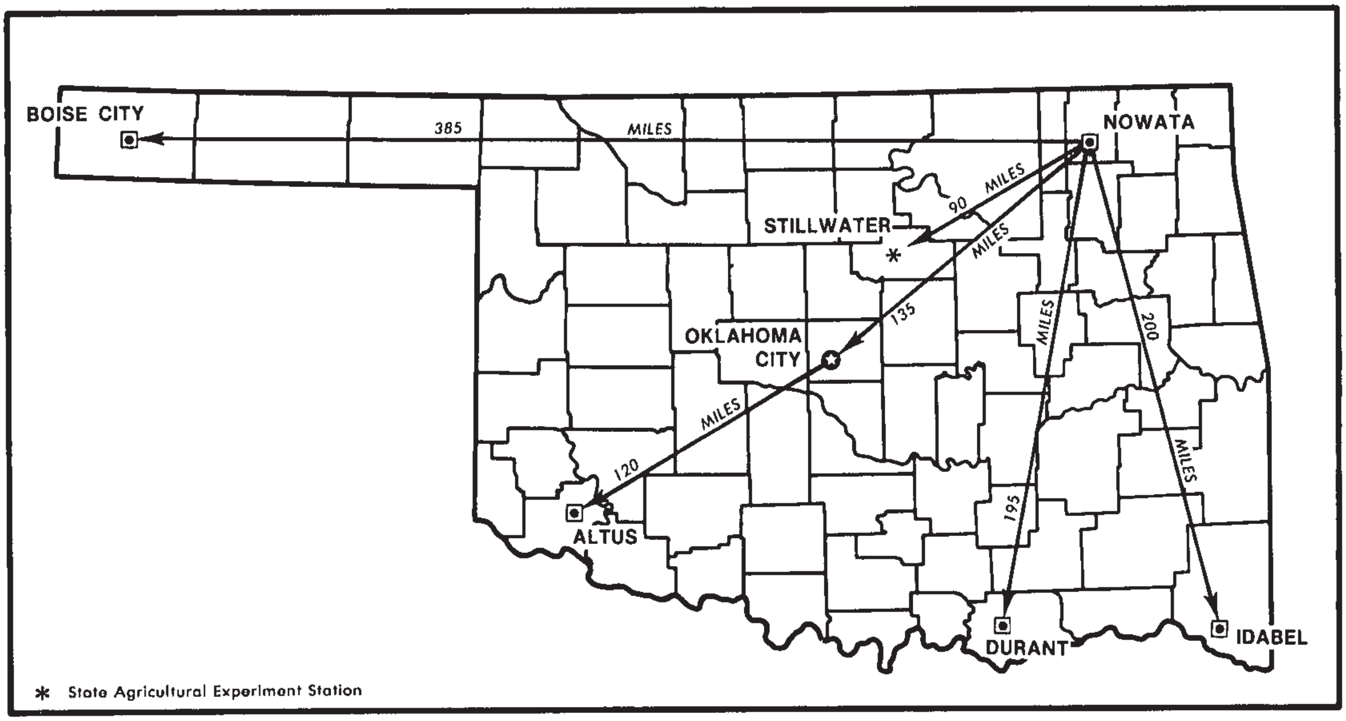
State Conservationist
Soil Conservation Service



Location of Nowata County in Oklahoma.

SOIL SURVEY OF NOWATA COUNTY, OKLAHOMA

By Dock J. Polone, Soil Conservation Service

United States Department of Agriculture,
Soil Conservation Service,
in cooperation with the
Oklahoma Agricultural Experiment Station

NOWATA COUNTY is in the northeastern part of Oklahoma. It is bounded on the west by Washington County, on the south by Rogers County, on the east by Craig County, and on the north by Kansas. Nowata, the county seat, is in the south-central part of the county. The county has an area of 369,280 acres, or 577 square miles.

The first permanent residents of the area now known as Nowata County were the Cherokee Indians. Indians of other tribes arrived later. The land was allotted to the Indians, but it could be leased under the supervision of the Indian Agency.

As other settlers, mainly cattlemen, came into the area farming became more intensive.

Farming is now the main occupation in the county. Many of the farms are diversified, but there are a number of ranches where only beef cattle are raised. The principal crops are wheat, grain sorghum, and soybeans. Most of the acreage is in tame pasture and native range.

The topography of Nowata County is nearly level to moderately steep. The general slope is south to north. Most of the county is drained by the Verdigris River and its tributaries. The Verdigris River flows south into the Oolagah Reservoir.

Nowata County has three types of areas—prairie, flood plain, and timberland over sandstone. The largest area is prairie. It is dominantly nearly level to gently sloping, but a smaller acreage is strongly sloping to moderately steep. The flood plains are along the Verdigris River and its tributaries and are nearly level. They range in width from a few hundred feet to more than a mile. The timbered sandstone is mostly sloping.

Climate

The consistent pattern of climate in Nowata County is one of cold winters and long hot summers. Heavy rains fall mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall is normally adequate for soybeans and grain sorghum and all other grain crops.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Nowata, Oklahoma, for the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 38 degrees F, and the average daily minimum is 27 degrees. The lowest temperature on record, -9 degrees, occurred at Nowata on January 5, 1959. In summer the average temperature is 80 degrees, and the average daily maximum is 92 degrees. The highest temperature, 117 degrees, was recorded on July 14, 1954.

Growing degree days, shown in table 1, are equivalent to "heat units." Beginning in spring, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 24 inches, or 63 percent, usually falls in April through September, which takes in the growing season for most crops. In 2 years in 10, the April to September rainfall is less than 18 inches. The heaviest 1-day rainfall during the period of record was 7.73 inches at Nowata on August 14, 1961. There are about 53 thunderstorms each year; approximately 22 occur in summer.

The average seasonal snowfall is 12 inches. The greatest snow depth at any one time during the period of record was 18 inches. On the average, 3 days have at least 1 inch of snow on the ground, but the number of days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night in all seasons,

and the average at dawn is about 80 percent. The percentage of possible sunshine is 70 in summer and 55 in winter. The prevailing wind is from the southwest. Average windspeed is highest, 13 miles per hour, in March.

Tornadoes and severe thunderstorms occur occasionally but are local and of short duration. Damage varies and is spotty. Hailstorms occur at times during the warmer part of the year but in an irregular pattern.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After classifying and naming the soils, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows the map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscape in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

1. Radley-Wynona-Mason

Deep, nearly level, moderately well drained and somewhat poorly drained loamy soils that have a loamy or clayey subsoil; on flood plains

This map unit makes up about 13 percent of the county. It is about 40 percent Radley soils, 27 percent Wynona soils, and 20 percent Mason soils. The rest of this map unit is made up of Osage soils.

Radley soils are deep, nearly level, and moderately well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderate. These soils are occasionally or frequently flooded.

Wynona soils are deep, nearly level, and somewhat poorly drained. They have a loamy surface layer and a loamy or clayey subsoil. Permeability is slow. These soils are occasionally flooded.

Mason soils are deep, nearly level, and moderately well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderately slow. These soils are subject to rare flooding.

Most of the soils in this map unit are used for wheat, grain sorghum, soybeans, alfalfa hay, pasture grasses, and trees.

The main management concerns are preventing flooding, providing drainage, and maintaining soil structure and fertility. These soils respond to good management.

2. Dennis-Parsons-Okemah

Deep, nearly level through gently sloping, moderately well drained and somewhat poorly drained loamy soils that have a clayey or loamy subsoil; on uplands

This map unit makes up about 32 percent of the county. It is about 40 percent Dennis soils, 30 percent Parsons soils, and 16 percent Okemah soils. The rest of this map unit is made up of Bates, Catoosa, Coweta, Eram, Mason, Radley, Riverton, and Wynona soils.

Dennis soils are deep, very gently sloping through gently sloping, and moderately well drained. They have a loamy surface layer and a clayey and loamy subsoil. Permeability is slow.

Parsons soils are deep, nearly level through very gently sloping, and somewhat poorly drained. They have a loamy surface layer and a clayey subsoil. Permeability is very slow.

Okemah soils are deep, nearly level, and moderately well drained. They have a loamy surface layer and a clayey subsoil. Permeability is slow.

Most of the soils in this map unit are used for wheat, grain sorghum, soybeans, alfalfa hay, pasture grasses, and native grasses.

The main management concerns are preventing excessive erosion and maintaining soil structure and fertility. Crops that produce a large amount of residue should be managed to help improve the soil. Plant food should be added for high level production.

3. Apperson-Catoosa-Summit

Deep and moderately deep, very gently sloping and gently sloping, moderately well drained and well drained loamy soils that have a clayey or loamy subsoil; on uplands

This map unit makes up about 18 percent of the county. It is about 29 percent Apperson soils, 28 percent Catoosa soils, and 16 percent Summit soils. The rest of this map unit is made up of Bates, Claremore, Coweta, Dennis, Eram, Kanima, Kiti, Nowata, Okemah, Parsons, Radley, and Riverton soils.

Apperson soils are deep, very gently sloping, and moderately well drained. They have a loamy surface layer and a clayey subsoil. Permeability is slow.

Catoosa soils are moderately deep, very gently sloping, and well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderate.

Summit soils are deep, gently sloping, and moderately well drained. They have a loamy surface layer and a clayey subsoil. Permeability is slow.

Most of the soils in this map unit are used for wheat, grain sorghum, soybeans, alfalfa hay, pasture grasses, and native grasses.

The main management concerns are preventing excessive erosion, maintaining soil structure and fertility, and managing droughtiness on the shallow soils. In cultivated areas the crop residue should be returned to the surface, and plant food should be added.

4. Shidler-Claremore-Kiti

Shallow, very gently sloping through sloping, well drained loamy soils that have a loamy subsoil; on uplands

This map unit makes up about 16 percent of the county. It is about 45 percent Shidler soils, 17 percent Claremore soils, and 8 percent Kiti soils. The rest of this map unit is made up of Apperson, Bates, Catoosa, Coweta, Dennis, Kanima, Nowata, and Radley soils and limestone outcrops.

Shidler soils are shallow, very gently sloping through sloping, and well drained. They have a loamy surface layer. Permeability is moderate.

Claremore soils are shallow, very gently sloping, and well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderate.

Kiti soils are shallow, very gently sloping through sloping, and well drained. They have a loamy surface layer. Permeability is moderate.

Most of the soils in this map unit are used for pasture grasses and native grasses. A few areas of Catoosa soils are used for wheat, grain sorghum, and soybeans.

The main management concern is controlling grazing.

5. Enders-Hector-Liberal

Shallow and deep, sloping, well drained and moderately well drained loamy soils that have a loamy or clayey subsoil; on uplands

This map unit makes up about 5 percent of the county. It is about 22 percent Enders soils, 18 percent Hector soils, and 14 percent Liberal soils. The rest of this map unit is made up of Apperson, Bates, Coweta, Dennis, Kiti, Radley, and Shidler soils.

Enders soils are deep, sloping, and well drained. They have a loamy surface layer and a loamy or clayey subsoil. Permeability is very slow.

Hector soils are shallow, sloping, and well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderately rapid.

Liberal soils are deep, sloping, and moderately well drained. They have a loamy surface layer and a clayey or loamy subsoil. Permeability is slow.

Most of the soils in this map unit are used for pasture grasses, native grasses, and trees.

The main management concern is controlling grazing.

6. Coweta-Bates-Eram

Shallow and moderately deep, very gently sloping through moderately steep, somewhat excessively drained through moderately well drained loamy soils that have a loamy or clayey subsoil; on uplands

This map unit makes up about 16 percent of the county. It is about 57 percent Coweta soils, 20 percent Bates soils, and 4 percent Eram soils. The rest of this map unit is made up of Apperson, Catoosa, Enders, Hector, Okemah, Parsons, and Radley soils.

Coweta soils are shallow, very gently sloping through moderately steep, and well drained to somewhat excessively drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderate.

Bates soils are moderately deep, very gently sloping through gently sloping, and well drained. They have a loamy surface layer and a loamy subsoil. Permeability is moderate.

Eram soils are moderately deep, very gently sloping through moderately steep, and moderately well drained. They have a loamy surface layer and a clayey and loamy subsoil. Permeability is slow.

Most of the soils in this map unit are used for pasture grasses and native grasses. Some areas are used for wheat, grain sorghum, and soybeans.

The main management concern is controlling grazing. In cultivated areas the residue should be managed to help improve the soils, and plant food should be added.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Parsons silt loam, 0 to 1 percent slopes, is one of several phases within the Parsons series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes or soil associations.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Coweta-Bates complex is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Enders-Hector association is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4; and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

AeB—Apperson silty clay loam, 1 to 3 percent slopes. This is a deep, moderately well drained, very gently sloping soil in broad valleys of the uplands. Slopes are smooth and convex. The areas are 50 to 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 10 inches thick. The upper part of the subsoil is very dark gray silty clay and extends to a depth of 22 inches. The lower part is dark grayish brown silty clay and extends to a depth of 44 inches. Below that is hard limestone bedrock.

This soil has a seasonal water table at a depth of 1½ to 2 feet below the surface. It has slow permeability and a high available water capacity. It has high natural fertility and a high content of organic matter.

Included with this soil in mapping are Summit soils, which make up 10 percent of the mapped areas, and soils similar to Apperson soils except that depth to bedrock is less or the middle and lower parts of the subsoil are less clayey; these make up 15 percent of the mapped areas. Okemah soils are also included and make up 5 percent.

This soil is suited to wheat, grain sorghum, soybeans, alfalfa hay, and other crops and to improved bermudagrass, tall fescue, and native grasses. Tilth can be maintained by returning crop residue to the surface. Plant food should be added for high level production. Erosion is a moderate hazard if the soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce runoff and control erosion.

If this soil is used for community development, the shrink-swell potential, low strength, and wetness are limitations. Capability subclass IIe; Loamy Prairie range site; not assigned to a woodland group.

CaB—Catoosa silt loam, 1 to 3 percent slopes. This is a moderately deep, well drained, very gently sloping soil on crests and in valleys of the uplands. Slopes are smooth and convex. The areas are 50 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 12 inches thick. The upper part of the subsoil is dark brown silty clay loam and extends to a depth of 18 inches. The lower part is dark reddish brown silty clay loam and extends to a depth of 35 inches. Hard limestone bedrock is at a depth of 35 inches.

This soil has moderate permeability and medium available water capacity. It has high natural fertility and a high content of organic matter.

Included with this soil in mapping are soils that are similar to the Catoosa soil except that the depth to hard limestone is more than 40 inches. These soils make up about 20 percent of the mapped areas. Also included, and making up 10 percent of the mapped areas, are soils that are similar to the Catoosa soil except that the depth to hard limestone is 15 to 20 inches. Soils that are similar to the Catoosa soil except that the subsoil is clay are also included; these also make up 10 percent of the mapped areas.

This soil is suited to wheat, grain sorghum, soybeans, and other crops and to improved bermudagrass, tall fescue, and native grasses. Tilth can be maintained by returning crop residue to the surface. Plant food should be added for high-level production.

Erosion is a moderate hazard if the soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system help reduce runoff and control erosion.

If this soil is used for sanitary facilities or community development, the depth to bedrock is a limitation. Capability subclass IIe; Loamy Prairie range site; not assigned to a woodland group.

CbB—Coweta-Bates complex, 1 to 5 percent slopes. This complex consists of areas of Coweta and Bates soils. The soils are so intermingled that mapping them separately was not practical. They are on broad crests and side slopes of the uplands. The complex is in areas of about 75 to 150 acres in size. Individual soils are in areas of 1 to 15 acres.

Coweta soils make up about 55 percent of the complex. These soils are shallow, well drained to somewhat excessively drained, and very gently sloping through gently sloping. They are on crests and upper parts of slopes. Slopes are smooth and convex. Typically, the surface layer is dark brown loam about 10 inches thick. The subsoil is brown loam that contains sandstone fragments; it extends to a depth of 16 inches. Soft fractured sandstone that has a few thin layers of shale is at a depth of 16 inches.

Coweta soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and medium fertility.

Bates soils make up about 25 percent of the complex. These soils are moderately deep, well drained, and very gently sloping through gently sloping. They are on the lower part of slopes below areas of Coweta soils. Slopes are smooth and concave. Typically, the surface layer is dark brown loam about 12 inches thick. The upper part of the subsoil is dark brown loam and extends to a depth of 18 inches. The lower part is brown clay loam and extends to a depth of 34 inches. Soft, fractured sand-

stone that has a few thin layers of shale is at a depth of 34 inches.

Bates soils have moderate permeability and a medium available water capacity. They have a high content of organic matter and high natural fertility.

Included with these soils in mapping are Eram soils and soils that are similar to Eram soils except that the colors of the surface layer and the depth to bedrock are different. These soils make up about 20 percent of the mapped areas.

This complex is suited to pasture grasses and native grasses. To obtain maximum production of herbage and to conserve water and control erosion, fertilizer should be applied to pasture grasses and grazing should be controlled.

If these soils are used for sanitary facilities or community development, the depth to bedrock is a limitation. Capability subclass VIe; Coweta part in Shallow Prairie range site, Bates part in Loamy Prairie range site; not assigned to a woodland group.

CeC—Coweta-Eram complex, 5 to 15 percent slopes. This complex consists of areas of Coweta and Eram soils. The soils are so intermingled that mapping them separately was not practical. The soils are on crests and side slopes and in valleys of the uplands. The complex is in areas of 50 to 200 acres in size, and the individual soils are in areas of 1 to 15 acres.

Coweta soils make up about 65 percent of the complex. These soils are shallow, well drained to somewhat excessively drained, and sloping through moderately steep. They are on crests and upper parts of slopes. Slopes are smooth and convex. Typically, the surface layer is dark brown fine sandy loam about 9 inches thick. The subsoil is brown fine sandy loam and extends to a depth of 14 inches. Soft fractured sandstone that has a few thin layers of shale and hard sandstone is at a depth of 14 inches.

Coweta soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and medium fertility.

Eram soils make up about 20 percent of the complex. These soils are moderately deep, moderately well drained, and very gently sloping through sloping. They are on the middle and lower parts of slopes. Slopes are smooth and concave. Typically, the surface layer is dark brown silt loam about 11 inches thick. The upper part of the subsoil is brown clay and extends to a depth of 20 inches. The lower part is yellowish brown clay and extends to a depth of 26 inches. Below that are layers of soft shale.

Eram soils have a seasonal water table at a depth of 2 to 3 feet below the surface. They have slow permeability and a medium available water capacity. They have a high content of organic matter and high fertility.

Included with these soils in mapping are soils that are similar to Eram soils except that they have a slightly less clayey subsoil. These soils make up 10 percent of the mapped areas. Bates soils are also included, and they make up 5 percent.

This complex is suited to native grasses and pasture grasses. To obtain maximum production of herbage and to conserve water and control erosion, grazing should be controlled and fertilizer should be applied to pasture grasses.

If these soils are used for sanitary facilities or community development, the thickness of Coweta and Eram soils and the shrink-swell potential of Eram soils are limitations. Capability subclass VIe; Coweta part in Shallow Prairie range site, Eram part in Loamy Prairie range site; not assigned to a woodland group.

DnB—Dennis silt loam, 1 to 3 percent slopes. This is a deep, moderately well drained, very gently sloping soil in valleys and on side slopes of the uplands. Slopes are smooth and convex. The areas are 50 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown silty clay loam and extends to a depth of 17 inches. The middle part is yellowish brown clay and extends to a depth of 48 inches. The lower part is coarsely mottled yellowish brown, light brownish gray, gray, and dark grayish brown clay to a depth of 78 inches.

This soil has a seasonal water table at a depth of 2 or 3 feet. Permeability is slow, and the available water capacity is high. Natural fertility and the content of organic matter are high.

Included with this soil in mapping are Parsons soils, which make up about 10 percent of the mapped areas, and soils that are similar to Dennis soils except that depth to shale is 40 to 60 inches or the lower part of their subsoil is not coarsely mottled; these make up 10 percent of the mapped areas. Bates soils are also included and make up 5 percent.

This soil is suited to wheat, grain sorghum, soybeans, alfalfa hay, and other crops and to improved bermudagrass, tall fescue, and native grasses (fig. 1). Tilth can be maintained by returning crop residue to the surface. Plant food should be added for high level production. Erosion is a moderate hazard if the soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce runoff and control erosion.

If this soil is used for sanitary facilities or community development, the slow permeability, clayey subsoil, high shrink-swell potential, and low strength are limitations. Capability subclass IIe; Loamy Prairie range site; not assigned to a woodland group.

DnC—Dennis silt loam, 3 to 5 percent slopes. This is a deep, moderately well drained, gently sloping soil in

valleys and on side slopes of the uplands. Slopes are smooth and convex. The areas are 50 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 13 inches thick. The upper part of the subsoil is brown silty clay loam and extends to a depth of 17 inches. The middle part is brown and yellowish brown clay and extends to a depth of 46 inches. The lower part of the subsoil, to a depth of 72 inches, is coarsely mottled yellowish brown, grayish brown, red, and yellowish red clay.

This soil has a seasonal water table at a depth of 2 or 3 feet. Permeability is slow, and the available water capacity is high. Natural fertility and the content of organic matter are high.

Included with this soil in mapping are Parsons soils and soils similar to Dennis soils except that the surface layer is thinner or the thickness to shale is less than 60 inches; each of these included soils makes up about 10 percent of the mapped areas. Also included are Okemah soils, which make up 5 percent of the mapped areas, and soils similar to Dennis soils except that the lower part of the subsoil is not coarsely mottled. These soils also make up 5 percent of the mapped areas.

This soil is suited to wheat, grain sorghum, soybeans, and improved bermudagrass, tall fescue, and native grasses. If row crops are grown, contour farming and terraces are needed. Crops that produce large amounts of residue should be managed for soil improvement. Plant food should be added for high level production. Erosion is a severe hazard if cultivated crops are grown. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system help reduce runoff and control erosion.

If this soil is used for sanitary facilities or community development, the slow permeability, clayey subsoil, high shrink-swell potential, and low strength are limitations. Capability subclass IIIe; Loamy Prairie range site; not assigned to a woodland group.

EHC—Enders-Hector association, sloping. This association consists of areas, about 200 to 500 acres in size, of Enders and Hector soils in a regular pattern. Enders soils are on side slopes, and Hector soils are on crests and microcrests of side slopes between areas of Enders soils. Slopes are 5 to 20 percent and are smooth and convex. Individual soils are in areas of 5 to 150 acres in size.

Enders soils make up about 45 percent of the association. These soils are deep, well drained, and sloping. Slopes are smooth and convex. Typically, the surface layer and the upper part of the subsoil are dark brown and brown loam 8 inches thick. The middle part of the subsoil is yellowish red clay. The lower part of the subsoil is coarsely mottled yellowish red, reddish brown, and pale brown clay and extends to a depth of 46 inches. Weathered soft shale that is mottled in shades of gray and brown is at a depth of 46 inches.

Enders soils have very slow permeability and a medium available water capacity. They have a low content of organic matter and low natural fertility.

Hector soils make up about 15 percent of the association. These soils are shallow, well drained, and sloping. Slopes are smooth and convex. Typically, the surface layer is dark brown fine sandy loam 4 inches thick. The subsurface layer is brown fine sandy loam 5 inches thick. The subsoil is yellowish brown fine sandy loam and extends to a depth of 18 inches. Yellowish brown, hard, fractured sandstone is at a depth of 18 inches.

Hector soils have moderately rapid permeability and a low available water capacity. They have a low content of organic matter and low natural fertility.

Included with these soils in mapping are soils that are similar to Enders soils except that the depth to shale is 20 to 32 inches and soils that are similar to Hector soils except that the depth to sandstone is less than 10 inches or more than 20 inches. Each of these soils makes up about 10 percent of the mapped areas. Also included are soils that are similar to Enders soils except that the upper part of the subsoil is slightly less clayey. These soils make up 20 percent of the mapped areas.

This association is suited to native grasses, pasture grasses, and trees. To obtain maximum production of herbage for livestock and to conserve water and control erosion, grazing should be controlled and fertilizer should be applied to pasture grasses.

If these soils are used for sanitary facilities or community development, the shrink-swell potential of Enders soils and the shallowness of Hector soils are limitations. Capability class VI; Enders part in Sandy Savannah range site, Hector part in Shallow Savannah range site; Enders part in woodland group 5o, Hector part in woodland group 5d.

ErD—Eram-Radley complex, 0 to 8 percent slopes. This complex consists of areas of Eram and Radley soils. The soils are so intermingled that mapping them separately was not practical. The soils are on narrow drainageways. The areas of this complex are about 50 to 100 acres in size, and the areas of individual soils are 5 to 15 acres.

Eram soils make up about 25 percent of the complex. These soils are moderately deep, moderately well drained, and very gently sloping through sloping. They are on short side slopes of narrow drainageways on the uplands. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The upper part of the subsoil is very dark grayish brown silty clay and extends to a depth of 16 inches. The lower part is dark grayish brown silty clay loam and extends to a depth of 28 inches. Grayish brown, weathered, soft shale is at a depth of 28 inches.

Eram soils have a seasonal water table at a depth of 2 to 3 feet below the surface. They have slow permeability and a medium available water capacity. They have a medium content of organic matter and medium natural fertility.

Radley soils make up about 20 percent of the complex. These soils are deep, moderately well drained, and nearly level. They are on narrow flood plains. Typically, the surface layer is dark brown silt loam about 18 inches thick. The subsoil is brown silt loam and extends to a depth of 30 inches. The underlying material, to a depth of 45 inches, is brown silt loam. A buried layer of very dark grayish brown silt loam is at a depth of 45 inches.

Radley soils have moderate permeability and a high available water capacity. They have a high content of organic matter and high natural fertility. These soils are frequently flooded.

Included with these soils in mapping are soils that are similar to Eram soils except that the subsoil colors are slightly different and soils that are similar to Parsons soils except that they are less than 40 inches deep to shale or the subsoil colors are slightly different. Each of these soils makes up about 10 percent of the mapped areas. Also included are a trace of Coweta soils; 10 percent Dennis soils; 5 percent soils that are similar to Dennis soils except that the depth to bedrock is less than 60 inches; 5 percent drainage channels; 5 percent Summit soils; and 10 percent soils that are similar to Radley soils except that the colors are more gray.

This complex is suited to pasture grasses and native grasses. To obtain maximum production of herbage and to conserve water and control erosion, fertilizer should be applied to pasture grasses and grazing should be controlled.

If these soils are used for sanitary facilities or community development, the moderate depth and shrink-swell potential of Eram soils and the frequent flooding of Radley soils are limitations. Capability subclass VIe; Eram part in Loamy Prairie range site, Radley part not assigned to a range site; Eram part not assigned to a woodland group, Radley part in woodland group 3o.

KaD—Kanima very shaly silt loam, 1 to 8 percent slopes. This is a deep, well drained, very gently sloping through sloping soil in areas of coal strip mine spoil and on irregular convex crests and side slopes. The areas are 200 to 400 acres in size.

Typically, the surface layer is very dark grayish brown, very shaly silt loam 4 inches thick. The underlying material is very dark grayish brown, very shaly silt loam to a depth of 70 inches.

This soil has moderate to moderately rapid permeability and a low available water capacity. It has low natural fertility and a low content of organic matter.

Included with this soil in mapping are minor amounts of Apperson, Claremore, and Shidler soils.

This soil is suited to pasture grasses and native grasses. To obtain maximum production of herbage and to conserve water and control erosion, fertilizer should be applied to pasture grasses and grazing should be controlled.

If this soil is used for community development, the irregular slope and low strength are limitations. Capability subclass VIIs; not assigned to a range site or woodland group.

LHC—Liberal-Hector association, sloping. This association consists of areas, 200 to 500 acres in size, of Liberal and Hector soils that are in a regular pattern. Liberal soils are on smooth, convex side slopes and microcrests, and Hector soils are on irregular, convex crests and microcrests of side slopes between areas of Liberal soils. The individual soils are in areas of 5 to 150 acres. Slopes are 5 to 20 percent.

Liberal soils make up about 30 percent of the association. These soils are deep, moderately well drained, and sloping. They are on uplands. Typically, the surface layer is very dark grayish brown silty clay loam 7 inches thick. The upper 5 inches of the subsoil is brown silty clay loam. The subsoil, to a depth of 35 inches, is grayish brown clay. The underlying matérial is grayish brown weathered shale and clay to a depth of 45 inches. Below that there is soft shale bedrock.

Liberal soils have a seasonal water table at a depth of 2 to 3 feet below the surface. They have slow permeability and a medium available water capacity. They have low natural fertility and a low content of organic matter.

Hector soils make up about 25 percent of the association. These soils are shallow, well drained, and sloping. Slopes are smooth and convex. Typically, the surface layer is dark brown loam 3 inches thick. The subsurface layer is brown loam 3 inches thick. The subsoil is yellowish brown loam and extends to a depth of 14 inches. Below that there is yellowish brown, hard, fractured sandstone.

Hector soils have moderately rapid permeability and a low available water capacity. They have low natural fertility and a low content of organic matter.

Included with these soils in mapping are soils that are similar to Liberal soils except that the depth to shale is less than 20 inches and other soils that are similar to Liberal soils except that the depth to shale is more than 40 inches. Each of these soils makes up about 10 percent of the mapped areas. Also included are 10 percent soils that have a less clayey subsoil than Liberal soils; 5 percent soils that are similar to Hector soils except that the depth to bedrock is less than 10 inches or more than 20 inches; and 10 percent soils that are similar to Liberal and Hector soils except that they formed in cherty limestone.

This association is suited to native grasses and pasture grasses. To obtain maximum production of herbage and to conserve water and control erosion, grazing

should be controlled and fertilizer should be applied to pasture grasses.

If these soils are used for sanitary facilities and community development, the shrink-swell potential, slow intake of water in the Liberal soils, and the shallowness of Hector soils are limitations. Capability subclass VIe; Liberal part in Loamy Prairie range site, Hector part in Shallow Savannah range site; Liberal part not assigned to a woodland group, Hector part in woodland group 5d.

Ma—Mason silt loam. This is a deep, moderately well drained, nearly level soil on narrow flood plains. Slopes are slightly convex and smooth. The areas are 30 to 100 acres in size.

Typically, the surface layer is very dark grayish brown silt loam 18 inches thick. The upper part of the subsoil is very dark grayish brown silt loam and silty clay loam and extends to a depth of 45 inches. The lower part is dark grayish brown silty clay loam to a depth of 64 inches.

This soil has moderately slow permeability and a high available water capacity. It is rarely flooded. It has a high content of organic matter and high natural fertility.

Included with this soil in mapping are Wynona soils, which make up about 15 percent of the mapped areas, and soils similar to Mason soils except that the dark colors in the upper horizons extend to a depth of less than 20 inches. These soils make up 10 percent of the mapped areas.

This soil is suited to wheat, grain sorghum, alfalfa hay, and other crops and to improved bermudagrass, tall fescue, and native grasses. Crops that produce large amounts of residue can be grown continuously if the residue is returned to the surface. Maintaining fertility and preserving soil structure are the main management concerns. Erosion is a slight hazard if the soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce the amount of runoff and control erosion.

If this soil is used for sanitary facilities and community development, the moderately slow permeability, rare flooding, and moderate shrink-swell potential are limitations. Capability class I; not assigned to a range site; woodland group 3o.

NoB—Nowata silt loam, 2 to 5 percent slopes. This is a moderately deep, well drained, very gently sloping through gently sloping soil on crests and upper parts of slopes on the uplands. Slopes are smooth and convex. The areas are 300 to 500 acres in size.

Typically, the surface layer is dark brown silt loam 12 inches thick. In the upper 6 inches the subsoil is brown silt loam. Below that, to a depth of 36 inches, it is reddish brown, very gravelly silty clay loam. Hard limestone bedrock is at a depth of 36 inches.

This soil has moderately slow permeability and a medium available water capacity. It has a high content of organic matter and medium natural fertility.

Included with this soil in mapping are about 5 percent Apperson or Summit soils, 5 percent Shidler soils, minor amounts of Dennis soils, and 10 percent soils that are similar to Nowata soils except that the depth to bedrock is more than 40 inches and the lower part of the subsoil is slightly more clayey.

This soil is suited to wheat, soybeans, grain sorghum, and other crops and to improved bermudagrass, tall fescue, and native grasses. Erosion is a very severe hazard if this soil is used for cultivated crops. Crops that produce large amounts of residue should be managed to improve the soil. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce runoff and control erosion. Plant food should be added if crops or pasture grasses are grown. These soils are best suited to native grasses or pasture grasses.

If this soil is used for sanitary facilities or community development, the moderately slow permeability, moderate depth to bedrock, low strength, and moderate shrink-swell potential are limitations. Capability subclass IVe; Loamy Prairie range site; not assigned to a woodland group.

Ow—Oil-waste land. This miscellaneous area has been so badly contaminated by accumulated liquid wastes, principally oil and saltwater, that it no longer supports vegetation. It includes slushpits and is on uplands and bottom lands in all parts of the county. The areas are generally about 3 acres in size but range from half an acre to 60 acres. They generally have a loamy surface layer and a loamy or clayey subsoil. The parent material is weathered sandstone, limestone, or shale, or it is alluvium. There is a high concentration of soluble salts in the areas. Slope ranges from 0 to 5 percent. Water runs off the surface rapidly, and the hazard of erosion is severe.

Oil-waste land is not suited to farming. Some areas could be reclaimed, but the cost would be high. Terraces can be constructed to divert the flow of wastes, and precipitation can be impounded to leach out the soluble salts. Hay or straw mulch can be used to reduce the rate of evaporation and thus prevent the accumulation of salts on the surface. Salt-tolerant plants can be grown if they are seeded or planted during rainy periods when salts are least concentrated. Capability subclass VIIIs; not assigned to a range site or woodland group.

OkA—Okemah silt loam, 0 to 1 percent slopes. This is a deep, moderately well drained, nearly level soil in valleys of the uplands. Slopes are smooth and slightly concave. The areas are 50 to 200 acres in size.

Typically, the surface layer is very dark brown silt loam and silty clay loam 18 inches thick. The upper part of the

subsoil is very dark gray and dark grayish brown silty clay and extends to a depth of 56 inches. The lower part is coarsely mottled gray, light gray, yellowish brown, and strong brown silty clay to a depth of 72 inches.

This soil has a seasonal water table at a depth of 2 to 3 feet below the surface. It has slow permeability and a high available water capacity. It has a high content of organic matter and high natural fertility.

Included with this soil in mapping are Parsons soils, which make up about 10 percent of the mapped areas, and Apperson soils and Dennis soils, which each make up 5 percent of the mapped areas.

This soil is suited to wheat, soybeans, grain sorghum, alfalfa hay, and other crops and to improved bermudagrass, tall fescue, and native grasses. Crops that produce large amounts of residue can be grown continuously if the residue is returned to the surface. Maintaining fertility and preserving soil structure are the main management concerns. Erosion is a slight hazard if this soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce the amount of runoff and control erosion.

If this soil is used for sanitary facilities and community development, the slow permeability, wetness, high shrink-swell potential, and low strength are limitations. Capability class I; Loamy Prairie range site; not assigned to a woodland group.

Os—Osage clay. This is a deep, poorly drained, nearly level soil on flood plains. Slopes are smooth and concave. The areas are 50 to 200 acres in size.

Typically, the surface layer is very dark gray clay 18 inches thick. The upper part of the subsoil is very dark gray clay and extends to a depth of 48 inches. The lower part is very dark gray and dark gray clay to a depth of 76 inches.

This soil has a seasonal water table at the surface or within a depth of 1 foot below the surface. It has very slow permeability and a medium available water capacity. It has high natural fertility and a high content of organic matter. This soil is occasionally flooded.

Included with this soil in mapping are Wynona soils, which make up about 15 percent of the mapped areas.

This soil is suited to soybeans, grain sorghum, wheat (fig. 2), and other crops and to tall fescue, improved bermudagrass, trees, and native grasses. This soil is poorly drained and difficult to till. A complete drainage system is needed. Crops that produce large amounts of residue can be grown continuously if the residue is returned to the surface.

Maintaining drainage and fertility and controlling the occasional flooding are the main management concerns. Erosion is a slight hazard if this soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help maintain soil structure and fertility.

If this soil is used for sanitary facilities and community development, the very slow permeability, occasional flooding, wetness, and high shrink-swell potential are limitations. Capability subclass IIIw; not assigned to a range site; woodland group 4w.

PaA—Parsons silt loam, 0 to 1 percent slopes. This is a deep, somewhat poorly drained, nearly level soil in valleys of the uplands. Slopes are smooth and slightly concave. The areas are 50 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam 9 inches thick. The subsurface layer is dark grayish brown silt loam 4 inches thick. The upper part of the subsoil is very dark grayish brown and dark grayish brown clay and extends to a depth of 36 inches. The lower part is coarsely mottled gray, light gray, yellowish brown, grayish brown, and brown clay to a depth of 72 inches.

This soil has a seasonal water table at a depth of 6 to 18 inches below the surface. It has very slow permeability and medium available water capacity. It has a medium content of organic matter and medium natural fertility.

Included with this soil in mapping are soils that are similar to this Parsons soil except that the colors are less gray and other soils that are also similar except that the combined thickness of the surface and subsurface layers is more than 16 inches. Each of these soils makes up about 10 percent of the mapped areas. Also included are Dennis soils and Okemah soils, each of which makes up 5 percent of the mapped areas, and a few slickspots.

This soil is suited to wheat, soybeans, grain sorghum, improved bermudagrass, tall fescue, and native grasses. It is best suited to cool-season crops. Erosion is a slight hazard if this soil is used for cultivated crops.

Maintaining soil structure, fertility, and surface drainage is the main management problem. Minimum tillage; row arrangement; addition of plant food; and the use of cover crops, including grasses and legumes, in the cropping system help to correct this problem.

If this soil is used for sanitary facilities and community development, the very slow permeability, wetness, high shrink-swell potential, and low strength are limitations. Capability subclass IIs; Claypan Prairie range site; not assigned to a woodland group.

PaB—Parsons silt loam, 1 to 3 percent slopes. This is a deep, somewhat poorly drained, very gently sloping soil in valleys of the uplands. Slopes are smooth and convex. The areas are 50 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam 9 inches thick. The subsurface layer is dark grayish brown silt loam 6 inches thick. The upper part of the subsoil is grayish brown and gray clay and extends to a depth of 40 inches. The lower part is coarsely mottled gray and yellowish brown clay to a depth of 74 inches.

This soil has a seasonal water table at a depth of 6 to 18 inches. Permeability is very slow, and the available water capacity is medium. Natural fertility and the content of organic matter are medium.

Included with this soil in mapping are soils that are similar to this Parsons soil except that the colors in the subsoil are less gray; these soils make up about 15 percent of the mapped areas. Also included are other soils that are similar to this Parsons soil except that the depth to shale is less than 60 inches; these soils make up 5 percent of the mapped areas. Inclusions of Dennis soils make up 10 percent of the mapped areas, and there are a few slickspots.

This soil is suited to wheat, grain sorghum, soybeans, improved bermudagrass, tall fescue, and native grasses. It is best suited to cool-season crops.

Contour farming and terraces are needed where row crops are grown. Crops that produce large amounts of residue should be managed to improve the soil (fig. 3). Plant food should be added for high level production. Erosion is a severe hazard if this soil is used for cultivated crops. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system help reduce runoff and control erosion.

If this soil is used for sanitary facilities and community development, the very slow permeability, wetness, high shrink-swell potential, and low strength are limitations. Capability subclass IIIe; Claypan Prairie range site; not assigned to a woodland group.

Pt—Pits. This miscellaneous area is mainly in areas of Apperson, Catoosa, Claremore, Kiti, and Shidler soils from which limestone fragments have been excavated. Some pits are in gravelly, sandy, and loamy areas of Coweta, Hector, Radley, and Riverton soils from which base material has been taken for roads, foundations, and other structures.

The areas range from 5 to 100 acres in size and from a few feet to 50 feet in depth.

Pits have no distinct soil profile. They have limitations for agricultural and urban use. They support small to moderate amounts of vegetation and can be lightly grazed or used for wildlife habitat. Some areas of Pits contain water. Not assigned to a capability subclass, range site, or woodland group.

Ra—Radley silt loam. This is a deep, moderately well drained, nearly level soil on flood plains. Slopes are slightly irregular and convex. The areas are 15 to 75 acres in size.

Typically, the surface layer is very dark grayish brown silt loam 18 inches thick. The subsoil is dark grayish brown silt loam and extends to a depth of 36 inches. The underlying material is dark grayish brown silt loam to a depth of 64 inches.

This soil has moderate permeability and a high available water capacity. It has a high content of organic matter and high natural fertility. This soil is occasionally flooded.

Included with this soil in mapping are soils that are similar to this Radley soil except that the dark colors of the surface layer extend to a depth of more than 24 inches; these soils make up about 15 percent of the mapped areas. Also included are Mason soils, Wynona soils, and soils that are similar to Radley soils except that the dark colored surface layer is less than 10 inches thick. Each of these makes up 5 percent of the mapped areas.

This soil is suited to wheat, grain sorghum, soybeans, alfalfa hay, tall fescue, improved bermudagrass, trees, and native grasses. Erosion is a slight hazard if this soil is used for cultivated crops. Maintaining fertility and soil structure and controlling occasional flooding are the main concerns in managing this soil. Crops can be grown continuously if the residue is returned to the surface. Minimum tillage, flood control structures, and the use of cover crops, including grasses and legumes, in the cropping system are practices that help in the management of this soil.

If this soil is used for sanitary facilities and community development, the occasional flooding and moderate shrink-swell potential are limitations. Capability subclass IIw; not assigned to a range site; woodland group 3o.

RD—Radley soils. These are deep, moderately well drained, nearly level soils on flood plains. Radley soils and the included soils are in an irregular pattern on the flood plains. Individual areas of each soil are large enough to map separately but not all components occur in one map unit. Slopes are slightly irregular and convex. Individual soils are in areas of 50 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam 18 inches thick. The subsoil is brown silt loam and extends to a depth of 48 inches. The underlying material is brown silt loam to a depth of 68 inches.

These soils have moderate permeability and a high available water capacity. They have a high content of organic matter and high natural fertility. These soils are frequently flooded.

Included with these soils in mapping are river channels, soils that are similar to this Radley soil except that the dark colored surface layer is more than 24 inches thick, other soils that are similar to this Radley soil except that the dark colored surface layer is less than 10 inches thick, and Wynona soils. Each of these makes up 10 percent of the mapped areas. Also included are minor areas of Osage soils.

These soils are suited to tall fescue, improved bermudagrass, and trees. Controlling frequent flooding and maintaining soil structure and fertility are the main concerns in managing this soil. To obtain maximum production of herbage and to conserve water and control erosion, fertilizer should be applied to pasture grasses, flood

control structures should be installed, and grazing should be controlled.

If these soils are used for sanitary facilities and community development, frequent flooding is a limitation. Capability subclass Vw; not assigned to a range site; woodland group 3o.

ReB—Riverton loam, 1 to 3 percent slopes. This is a deep, well drained, very gently sloping soil on smooth convex crests and side slopes of the uplands. The areas are 50 to 200 acres in size.

Typically, the surface layer is dark brown loam 9 inches thick. The upper part of the subsoil is reddish brown, gravelly clay loam and very gravelly clay loam and extends to a depth of 30 inches. The lower part is yellowish red, very gravelly clay loam to a depth of 80 inches.

This soil has moderate permeability and a medium available water capacity. It has a high content of organic matter and medium natural fertility.

Included with this soil in mapping are Dennis soils, which make up a small part of the mapped areas.

This soil is suited to wheat, grain sorghum, soybeans, improved bermudagrass, tall fescue, trees, and native grasses. Erosion is a moderate hazard if this soil is used for cultivated crops.

Tilth can be maintained by returning crop residue to the surface. Plant food should be added for high level production. Minimum tillage; terraces; and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce runoff and control erosion.

This soil is suited to most sanitary facilities and community development. If this soil is used for sewage lagoons, seepage and small stones are limitations. This soil is used as a source of gravel. Capability subclass IIe; Loamy Savannah range site; woodland group 5f.

ScB—Shidler-Claremore complex, 1 to 3 percent slopes. This complex consists of areas of Shidler and Claremore soils that are so intermingled that mapping them separately was not practical. The soils are on broad crests and side slopes of the uplands. The areas are about 100 to 300 acres in size. Areas of each soil are 1 to 15 acres in size.

Shidler soils make up about 50 percent of the complex. These soils are shallow, well drained, and very gently sloping. They are on crests and side slopes. Slopes are slightly irregular and convex. Typically, the surface layer is very dark brown silt loam 13 inches thick. Below that there is hard fractured limestone.

Shidler soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and medium natural fertility.

Claremore soils make up about 30 percent of the complex. These soils are shallow, well drained, and very gently sloping. They are on crests and side slopes between areas of Shidler soils. Slopes are slightly irregular and convex. Typically, the surface layer is very dark grayish brown silt loam 8 inches thick. In the upper 4 inches the subsoil is very dark grayish brown silt loam. Below that, to a depth of 18 inches, it is dark brown silty clay loam. Below that there is hard, fractured limestone.

Claremore soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and medium natural fertility.

Included with these soils in mapping are Catoosa soils and Apperson soils. Each of these soils makes up about 10 percent of the mapped areas. Also included are a few areas of Kiti soils and of limestone outcrop.

This complex is suited to native grasses and pasture grasses. To obtain maximum production of herbage and to conserve water and control erosion, grazing should be controlled and fertilizer should be applied to pasture grasses.

If these soils are used for sanitary facilities and community development, the shallowness of the soils and low strength are limitations. Capability subclass VIe; Shidler part in Very Shallow range site, Claremore part in Loamy Prairie range site; not assigned to a woodland group.

SkD—Shidler-Kiti-Limestone outcrop complex, 1 to 8 percent slopes. This complex consists of small areas of Shidler and Kiti soils and Limestone outcrop that are so intermingled that mapping them separately was not practical. The areas of this complex are 100 to 300 acres in size, and they are on crests and side slopes of the uplands. The areas of each soil and the Limestone outcrop are 1 to 15 acres in size.

Shidler soils make up about 45 percent of the complex. These soils are shallow, well drained, and very gently sloping through sloping. They are on crests and side slopes. Slopes are slightly irregular and convex. Typically, the surface layer is dark brown silt loam 15 inches thick. Below that there is hard, fractured limestone.

Shidler soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and medium natural fertility.

Kiti soils make up about 25 percent of the complex. These soils are shallow, well drained, and very gently sloping through sloping. They are on crests and side slopes between areas of Shidler soils and Limestone outcrop. Slopes are slightly irregular and convex. Typically, the surface layer is 7 inches of very dark brown, channery silty clay loam and 6 inches of very dark brown, very channery silty clay loam. Below that, there is hard, fractured limestone.

Kiti soils have moderate permeability and a low available water capacity. They have a medium content of organic matter and high natural fertility.

Limestone outcrop makes up about 15 percent of the complex. It is on crests and side slopes between areas of Shidler and Kiti soils.

Included in mapping are Claremore soils, which make up about 10 percent of the mapped areas, Catoosa soils, which make up 5 percent, and a few areas of Coweta soils.

This complex is suited to native grasses. To obtain maximum production of herbage and to conserve water and control erosion, grazing should be controlled.

If these soils are used for sanitary facilities or community development, the shallowness of the soils, small stones, and limestone outcrops are limitations. Capability subclass VIIs; Shidler part in Very Shallow range site, Kiti part in Edge Rock range site; not assigned to a woodland group.

SuC—Summit silty clay loam, 3 to 5 percent slopes. This is a deep, moderately well drained, gently sloping soil on side slopes of the uplands. Slopes are smooth and convex. The areas are 50 to 100 acres in size.

Typically, the surface layer is very dark brown silty clay loam 11 inches thick. The upper part of the subsoil, to a depth of 26 inches, is very dark grayish brown silty clay loam and silty clay. The lower part, to a depth of 80 inches, is olive brown silty clay.

This soil has a seasonal water table at a depth of 2 to 3 feet below the surface. It has slow permeability and a high available water capacity. It has a high content of organic matter and high natural fertility.

Included with this soil in mapping are Apperson soils, which make up about 10 percent of mapped areas, Okemah soils, which make up 5 percent, and small areas of Catoosa and Shidler soils.

This soil is suited to wheat, grain sorghum, soybeans, improved bermudagrass, tall fescue, and native grasses. Erosion is a severe hazard if this soil is used for cultivated crops. Contour farming and terraces are needed in areas where row crops are grown. Crops that produce large amounts of residue should be managed to improve the soil. Plant food should be added for high level production. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help reduce runoff and control erosion.

If this soil is used for sanitary facilities or community development, the slow permeability, clayey subsoil, high shrink-swell potential, and low strength are limitations. Capability subclass IIIe; Loamy Prairie range site; not assigned to a woodland group.

Wa—Wynona silty clay loam. This is a deep, somewhat poorly drained, nearly level soil on flood plains. Slopes are smooth and concave. The areas are 50 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam 20 inches thick. The upper part of the subsoil is very dark gray silty clay loam and extends to a depth of 42 inches. The lower part is dark gray silty clay to a depth of 65 inches.

This soil has a seasonal water table at a depth of 0 to 2 feet below the surface. It has slow permeability and a high available water capacity. This soil has a high content of organic matter and high natural fertility. It is occasionally flooded.

Included with this soil in mapping are Osage soils, which make up 15 percent of the mapped areas; Mason soils, which make up 10 percent; and Radley soils, which make up 5 percent.

This soil is suited to wheat, grain sorghum, soybeans, improved bermudagrass, tall fescue, alfalfa hay, trees, and native grasses. Erosion is a slight hazard if this soil is used for cultivated crops.

This soil is somewhat poorly drained, and a drainage system is needed. High residue producing crops can be grown continuously if the residue is returned to the surface. Maintaining drainage and fertility and controlling occasional flooding are the main management concerns. Minimum tillage and the use of cover crops, including grasses and legumes, in the cropping system are practices that help maintain soil structure and fertility.

If this soil is used for sanitary facilities or community development, the slow permeability, wetness, occasional flooding, and low strength are limitations. Capability subclass IIw; not assigned to a range site; woodland group 3w.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to

these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

Theodore B. Lehman, conservation agronomist, and Grover W. Adams, district conservationist, Soil Conservation Service, helped prepare this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the predicted yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

The soils in Nowata County have good potential for increased production of food. In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the survey area. This soil survey can help facilitate the application of such technology.

Acreage in crops has gradually been decreasing as more and more land is used for pasture. The use of this soil survey to help make land use decisions that will influence the future role of farming in the county is discussed in the section "General soil map for broad land use planning."

Soil erosion is the major concern on cropland in Nowata County. If slope is more than 1 percent, erosion is a hazard. Apperson, Catoosa, Dennis, Nowata, and Summit soils, for example, are subject to erosion.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging to soils that have a clayey subsoil, such as Apperson, Okemah, Parsons, and Summit soils. Erosion also reduces productivity on soils that tend to be droughty, such as Shidler and Kiti soils. Second, soil erosion results in the sedimentation of streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land, provide nitrogen, and improve tilth for the following crop.

Minimum tillage and leaving crop residue on the surface help increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area, but they are more difficult to use successfully on the eroded soils and on the soils that have a clayey surface layer, such as Osage soils. No-tillage is effective in reducing erosion on sloping land and can be adapted to most soils in the survey area. It is more difficult to practice successfully, however, on the soils that have a clayey surface layer.

Terraces and diversions reduce the length of slope and reduce runoff and erosion. They are not practical on deep, well drained soils that have regular slopes. Apperson and Dennis soils are suitable for terraces. Some soils are less suitable for terraces and diversions because of irregular slopes, excessive wetness, a clayey subsoil, which would be exposed in terrace channels, or bedrock at a depth of less than 40 inches.

Contouring and contour stripcropping are suitable erosion control practices in the survey area. They are best adapted to soils that have smooth, uniform slopes, including most areas of the sloping Apperson, Catoosa, Dennis, Nowata, Parsons, and Summit soils.

Soil drainage is needed on some of the acreage used for crops and pasture in the survey area. Osage and Wynona soils, for example, need to be drained.

Soil fertility is not naturally low in most soils in the survey area. All of the soils, however, require additional

plant food for the economical production of crops and pasture grasses. Many upland soils are acid, and ground limestone must be applied to raise the pH level sufficiently for good growth of alfalfa and other crops that grow best on nearly neutral soils. On all soils, the addition of lime and plant food should be based on the results of soil tests, on the need of the crop, and on the expected level of yields.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous.

Most soils used for crops in the survey area have a loamy surface layer. Generally, the structure of such soils is weak, and intense rainfall causes a crust to form on the surface. The crust is hard and nearly impervious to water when the surface is dry. Once the crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material help to improve soil structure and to reduce crust formation.

The soils and climate of the survey area are suited to many field crops that are not now commonly grown. Grain sorghum and soybeans are the commonly grown row crops, and wheat and oats are the common close-growing crops. Rye and barley are also grown.

Crop residue management consists of leaving crop residue on the surface during winter and spring or working it partly into the surface as needed to protect the soils from erosion. Organic matter or humus, supplied in crop residue, improves the tilth of the surface layer. Good tilth increases infiltration, increases storage of water, reduces the hazard of erosion, and helps prevent surface crusting.

Soil-improving crops are used mainly to maintain or improve the physical condition and the productivity of the soil and to control erosion, weeds, insects, and diseases. A cropping system that improves the soil includes crops that produce large amounts of residue. The residue and the addition of plant food help maintain soil structure and fertility.

Tame pasture plants

General guidelines for managing soils for tame pasture plants are described in this section. Those desiring more detailed information about management of soils can refer to the section "Soil maps for detailed planning."

Much of the acreage in Nowata County is in tame pasture. The trend is to convert cropland and woodland to pasture. To a lesser degree, rangeland is also being converted to pasture.

The principal grass grown in the county is improved bermudagrass. Some of the best bermudagrass pastures are overseeded with legumes, which provide additional plant food and increase the quality and quantity of forage.

Fescue is an important grass in the county, and it is overseeded with bermudagrass in some places. Fescue provides sufficient forage on soils in which large amounts of moisture are available (fig. 4). It is used in pastures with other forage plants to furnish grazing and additional protein late in fall and in spring. For fescue to be vigorous, it needs to be fertilized early in spring and fall; it should not be grazed in summer.

Some areas of cropland are used for growing forage plants to supplement permanent grasses. Small grains provide grazing and added protein for livestock late in fall and in spring. They need to be seeded and fertilized late in summer or early in fall to obtain the maximum amount of forage. Forage production can be compared favorably with fescue. Small grains can be grazed until maturity, or livestock can be removed in the spring to allow the plants to grow a seed crop for harvest. Wheat, oats, barley, and rye are the main small grains used for grazing.

Forage sorghum is also used on some cropland to supplement the permanent grasses. It can be used to provide grazing in summer or can be harvested for hay. In some areas, forage sorghum is allowed to grow until frost occurs, and it is grazed in winter. Fertilizer is necessary to obtain maximum sorghum production. Forage production can be compared favorably with improved bermudagrass.

Planning a pasture program

A pasture program should be planned to provide the desired amount of forage during each month of the year. A study of the growth habits of the different plants is necessary to assure adequate forage each month. Figure 5 shows the percentage of annual growth, by month, of forage plants. For example, bermudagrass makes 20 percent of its yearly growth for grazing during the month of June.

Soils vary in their ability to produce forage for grazing. The Mason soil produces more forage than the Dennis soil primarily because it furnishes more moisture to the plant. The total yearly production on each soil of various kinds of pasture plants is given in animal-unit-months (AUM) in table 5. For example, bermudagrass pasture on Dennis loam, 1 to 3 percent slopes, can furnish grazing for one animal unit for about 7 months in 1 year.

In planning a pasture program, the total yearly production of the pasture plant in animal-unit-months and the amount of growth the plant will make for a certain month should be considered. Bermudagrass, which makes 20 percent of its annual growth during June, will provide grazing for 1.4 animals on an acre of the Dennis soil in June because its yearly production is 7.0 AUM, as indicated in table 5 (7.0 AUM X 20 percent = 1.4 AUM). A pasture of 50 acres would then furnish grazing for 70.0 animals (50 acres X 1.4 AUM = 70.0 AUM) during June.

The Soil Conservation Service or Cooperative Extension Service can help plan a pasture program.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the soil is not suited to the crop or the crop is not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

Ernest C. Snook, range conservationist, Soil Conservation Service, helped prepare this section.

Rangeland consists of native grassland and includes wooded areas that are used primarily for grazing. Rangeland makes up about half of the survey area. The sale of livestock and livestock products accounts for more than half of farm income in the county. Cow-calf operations are dominant.

On many ranches the forage produced on rangeland is supplemented by crop stubble and small grains. In winter the native forage is often supplemented with protein concentrate. Creep feeding of calves and yearlings to increase market weight is practiced on some ranches.

The native vegetation in many parts of the survey area has been greatly depleted by continued excessive use. Much of the acreage that was once open grassland is now covered with brush and weeds. The amount of forage produced may be less than half of that originally produced. Productivity of the range can be increased by using management practices that are effective for specific kinds of soil and range sites.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic vegetation—the grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community—on each soil is listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential (fig. 6). Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The major management concern on most of the rangeland is control of grazing so that the kinds and amounts of plants that make up the potential plant community are re-established. Controlling brush and minimizing soil erosion are also important management concerns. If sound range management based on the soil survey information and rangeland inventories is applied, the potential is good for increasing the productivity of range in the area.

Woodland management and productivity

Norman E. Smola, woodland conservationist, Soil Conservation Service, helped prepare this section.

Table 7 contains information useful to woodland owners or forest managers in planning the use of the soils for wood crops. Only those soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates insignificant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the following order: x, w, t, d, c, s, f, and r.

In table 7 the soils are also rated for a number of factors to be considered in management. *Slight, moderate,* and *severe* are used to indicate the degree of major soil limitations.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if some measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings. Plant competition is not considered in the ratings. Seedlings from good planting stock that are properly planted during a period of sufficient rainfall are rated. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index.* This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Woodland understory vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. Some types of forest, under proper management, can produce enough understory vegetation to support grazing of livestock or wildlife, or both.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees, the density of the canopy, and the depth and condition of the forest litter. The density of the forest canopy affects the amount of light that understory plants receive during the growing season.

Table 8 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The table also lists the common names of the characteristic vegetation that grows on a specified soil and the percentage composition, by air-dry weight, of each kind of plant. The kind and percentage of understory plants listed in the table are those to be expected where canopy density is most nearly typical of forests that yield the highest production of wood crops.

The total production of understory vegetation is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the soil moisture is above average during the optimum part of the growing season; in a normal year soil moisture is average; and in an unfavorable year it is below average.

Engineering

William E. Hardesty and Robert F. Heidlage, engineers, Soil Conservation Service, helped prepare this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known

relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 9 shows, for each kind of soil, the degree and kind of limitations for building site development; table 10, for sanitary facilities; and table 12, for water management. Table 11 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 9. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 9 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-

swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 9 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 10 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, and *poor*, which mean about the same as *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard if the seasonal high water table is above the level of the lagoon floor. If the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 10 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the site should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 11 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 15 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low frost action potential, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 11 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 15.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can restrict plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils that have suitable layers less than 8

inches thick; soils that have large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 12 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the specified use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of the soil for use in embankments, dikes, and levees.

Aquifer-fed excavated ponds are bodies of water made by excavating a pit or dugout into a ground-water aquifer. Excluded are ponds that are fed by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Ratings in table 12 are for ponds that are properly designed, located, and constructed. Soil properties and site features that affect aquifer-fed ponds are depth to a permanent water table, permeability of the aquifer, quality of the water, and ease of excavation.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 13 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 13 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 10, and interpretations for dwellings without basements and for local roads and streets, given in table 9.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but re-

mains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Jerome F. Sykora, biologist, Soil Conservation Service, helped prepare this section.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 14, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, sorghum, wheat, oats, barley, millet, buckwheat, cowpeas, soybeans, and sunflowers.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bluestems, panicums, lovegrass, switchgrass, bromegrass, orchardgrass, clover, alfalfa, serecia, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, indiangrass, ragweed, goldenrod, beggarweed, sunflowers, pokeweed, partridgepea, wheatgrass, native lespedezas, fescue, and grama.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of hardwood plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, persimmon, sassafras, hickory, pecan, black walnut, blackberry, blackhaw, viburnum, red mul-

berry, and osage orange. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, eastern redcedar, and other juniper species.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are coralberry, sumac, green briers, skunkbush, roughleaf dogwood, huckleberry, and sand plum.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, rushes, sedges, reeds, saltgrass, cordgrass, and cattail.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with forbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, vireos, woodpeckers, tree squirrels, gray fox, raccoon, and deer.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 15 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 15 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 15 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7

to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Estimates of the percentage, by weight, of rock fragments more than 3 inches in diameter are given for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and in plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 16 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems. It is commonly expressed as inches of water per inch of soil.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil materi-

al. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Soil and water features

Table 17 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*4*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the

order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplaquolls (*Hapl*, meaning simple horizons, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group may be divided into three kinds of subgroups: the central (typic) concept of the great group, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great group; and the extragrades, which have some properties that are representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Vertic* identifies the subgroup that intergrades to Vertisols. An example is Vertic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, montmorillonitic, thermic, Vertic Haplaquolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*3*). Unless otherwise noted, colors described are for moist soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Apperson series

The Apperson series consists of deep, moderately well drained, slowly permeable, very gently sloping soils on uplands. The soils formed in materials that weathered from limestone under a cover of grass.

Typical pedon of Apperson silty clay loam, in an area of Apperson silty clay loam, 1 to 3 percent slopes, about 450 feet south and 150 feet west of the northeast corner of sec. 11, T. 26 N., R. 14 E.

A1—0 to 10 inches; very dark gray (10YR 3/1) silty clay loam; moderate coarse granular structure; firm; slightly acid; gradual smooth boundary.

B1—10 to 15 inches; very dark gray (10YR 3/1) silty clay; moderate medium subangular blocky structure parting to moderate coarse granular; firm; mildly alkaline; gradual smooth boundary.

B21t—15 to 22 inches; very dark gray (10YR 3/1) silty clay; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine blocky structure; very firm; faces of peds are shiny or there is a nearly continuous clay film on faces of peds; mildly alkaline; diffuse smooth boundary.

B22t—22 to 34 inches; dark grayish brown (2.5Y 4/2) silty clay; common coarse faint olive brown (2.5Y 4/4) mottles; weak fine blocky structure; extremely firm; shiny pressure faces or clay films on faces of peds; mildly alkaline; diffuse smooth boundary.

B3—34 to 44 inches; dark grayish brown (2.5Y 4/2) silty clay; common coarse distinct light olive brown (2.5Y 5/4) mottles; weak coarse blocky structure; extremely firm; few slickensides; moderately alkaline; abrupt irregular boundary.

R—44 to 46 inches; unweathered hard limestone bedrock.

Solum thickness and depth to hard limestone range from 40 to 60 inches. A seasonal water table is at a depth of 1 1/2 to 2 feet below the surface.

The A1 or Ap horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is slightly acid to medium acid.

The B1 horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is silty clay loam or silty clay. It ranges from medium acid to mildly alkaline.

The B21t horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or dark gray (10YR 4/1). Some pedons have mottles in shades of red or brown. The B21t horizon ranges from slightly acid to mildly alkaline.

The B22t horizon is very dark grayish brown (10YR 3/2), dark gray (10YR 4/1), or dark grayish brown (10YR 4/2; 2.5Y 4/2). Some pedons have mottles in shades of gray, brown, yellow, or red. The B22t horizon ranges from slightly acid to moderately alkaline. There are a few fine iron-manganese oxide and calcium carbonate concretions in some pedons.

The B3 horizon is dark grayish brown (10YR 4/2; 2.5Y 4/2), yellowish brown (10YR 5/4), or light olive brown (2.5Y 5/4). Most pedons have mottles in shades of gray, brown, yellow, or red. The B3 horizon ranges from slightly acid to moderately alkaline. There are a few limestone fragments in some areas.

The Apperson soils are in broad valleys and are associated with Catoosa, Claremore, Kanima, and Summit soils. Catoosa and Claremore soils are less than 35 percent clay in the control section. Kanima soils are loamy-skeletal. The solum of Summit soils is more than 60 inches thick.

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable, very gently sloping through gently sloping soils on uplands (fig. 7). The soils formed in material that weathered from sandstone interbedded with shale under a cover of grass.

Typical pedon of Bates loam, in an area of Coweta-Bates complex, 1 to 5 percent slopes, about 2,140 feet east and 50 feet north of the southwest corner of sec. 22, T. 25 N., R. 14 E.

A1—0 to 12 inches; dark brown (7.5YR 3/2) loam; moderate medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—12 to 18 inches; dark brown (7.5YR 3/2) loam; weak coarse subangular blocky structure; friable; medium acid; gradual smooth boundary.

B2t—18 to 30 inches; brown (7.5YR 4/4) clay loam; few fine faint yellowish brown mottles; moderate medium subangular blocky structure; firm; thin clay films on faces of peds; medium acid; gradual smooth boundary.

B3—30 to 34 inches; brown (7.5YR 4/4) clay loam; weak medium blocky structure; firm; thin clay films on faces of peds; few sandstone fragments; medium acid; clear smooth boundary.

Cr—34 to 36 inches; soft fractured sandstone with few thin layers of shale.

Solum thickness and depth to soft sandstone range from 20 to 40 inches.

The A1 or Ap horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3; 7.5YR 3/2). It is loam or sandy loam. It ranges from strongly acid to medium acid. In limed areas it is slightly acid or neutral.

The B1 horizon is brown (7.5YR 4/4), dark brown (10YR 3/3; 7.5YR 3/2), or dark yellowish brown (10YR 4/4). It is loam or sandy clay loam. It ranges from strongly acid to slightly acid.

The B2t or B3 horizon is brown (7.5YR 4/4; 10YR 4/3, 5/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4, 5/6). It is loam, clay loam, or sandy clay loam. It ranges from strongly acid to medium acid.

The Bates soils are on crests and in valleys and are associated with Coweta and Dennis soils. Coweta soils have a shallow solum, and Dennis soils have a fine control section.

Catoosa series

The Catoosa series consists of moderately deep, well drained, moderately permeable, very gently sloping soils on uplands. The soils formed in materials that weathered from limestone under a cover of grass.

Typical pedon of Catoosa silt loam, in an area of Catoosa silt loam, 1 to 3 percent slopes, about 1,800 feet south and 150 feet west of the northeast corner of sec. 11, T. 26 N., R. 14 E.

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—12 to 18 inches; dark brown (7.5YR 3/2) silty clay loam; weak medium subangular blocky structure parting to moderate medium granular; firm; few fine iron-manganese oxide concretions; medium acid; gradual smooth boundary.

B2t—18 to 35 inches; dark reddish brown (5YR 3/4) in upper part and reddish brown (2.5YR 4/4) in lower part, silty clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; few fine iron-manganese oxide concretions; medium acid; abrupt wavy boundary.

R—35 to 37 inches; hard limestone bedrock.

Solum thickness and depth to hard limestone bedrock range from 20 to 40 inches.

The A1 or Ap horizon is very dark grayish brown (10YR 3/2), dark brown (7.5YR 3/2), or dark reddish brown (5YR 2/2, 3/2). It ranges from medium acid to slightly acid.

The B1 horizon is dark brown (7.5YR 3/2) or dark reddish brown (5YR 3/3). It is silt loam, silty clay loam, or clay loam. It ranges from medium acid to slightly acid.

The B2t horizon is dark reddish brown (5YR 3/3, 3/4; 2.5YR 3/4) or dusky red (2.5YR 3/2). It is silty clay loam or clay loam. It ranges from strongly acid to neutral. There are a few limestone fragments in the lower part of the B2t horizon in some pedons.

The Catoosa soils are on crests and in valleys and are associated with Apperson, Claremore, Nowata, and Shidler soils. Apperson soils have a fine control section.

Claremore and Shidler soils have a solum that is less than 20 inches thick. Nowata soils have a loamy-skeletal control section.

Claremore series

The Claremore series consists of shallow, well drained, moderately permeable, very gently sloping soils on uplands. The soils formed in materials that weathered from limestone under a cover of grass.

Typical pedon of Claremore silt loam, in an area of the Shidler-Claremore complex, 1 to 3 percent slopes, about 600 feet south and 100 feet west of the northeast corner of sec. 28, T. 28 N., R. 17 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam; strong medium granular structure; friable; slightly acid; gradual smooth boundary.

B2t—12 to 18 inches; dark brown (7.5YR 3/2) silty clay loam; moderate medium subangular blocky structure; firm; thin clay films on faces of peds; medium acid; abrupt wavy boundary.

R—18 to 20 inches; hard fractured limestone.

Solum thickness and depth to bedrock range from 10 to 20 inches.

The A1 or Ap horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3). It ranges from medium acid to slightly acid.

The B1 horizon, where present, is very dark brown (10YR 2/2), dark brown (10YR 3/3; 7.5YR 3/2), or very dark grayish brown (10YR 3/2). It is silt loam or silty clay loam. It ranges from medium acid to slightly acid.

The B2t horizon is very dark brown (10YR 2/2), dark brown (10YR 3/3; 7.5YR 3/2), very dark grayish brown (10YR 3/2), or dark reddish brown (5YR 3/4). It ranges from medium acid to neutral.

The Claremore soils are on crests and side slopes and are associated with Apperson, Catoosa, Kanima, Shidler, and Summit soils. Apperson and Summit soils have a fine control section. Catoosa soils have a solum that is 20 to 40 inches thick. Kanima soils have a loamy-skeletal control section. Shidler soils do not have an argillic horizon.

These soils are taxadjuncts to the Claremore series because the dark brown or very dark brown B2t horizon in hue of 7.5YR and 10YR is outside the series range. Management needs are the same as those of the soils in the Claremore series.

Coweta series

The Coweta series consists of shallow, well drained to somewhat excessively drained, moderately permeable, very gently sloping through moderately steep soils on uplands (fig. 8). The soils formed in materials that weathered from sandstone interbedded with shale under a cover of grass.

Typical pedon of Coweta loam, in an area of Coweta-Bates complex, 1 to 5 percent slopes, about 2,000 feet east and 250 feet north of the southwest corner of sec. 22, T. 25 N., R. 14 E.

A1—0 to 10 inches; dark brown (7.5YR 3/2) loam; weak fine granular structure; friable; few sandstone fragments; slightly acid; gradual wavy boundary.

B2—10 to 16 inches; brown (7.5YR 4/2) loam; weak fine granular structure; friable; 15 percent sandstone fragments; medium acid; abrupt wavy boundary.

Cr—16 to 24 inches; strong brown (7.5YR 5/6) fractured soft sandstone with few thin layers of shale.

Solum thickness and depth to soft sandstone range from 10 to 20 inches.

The A1 horizon is dark brown (10YR 3/3; 7.5YR 3/2) or very dark grayish brown (10YR 3/2). It is loam or fine sandy loam. It ranges from strongly acid to slightly acid. Coarse fragments of sandstone that are less than 10 inches in diameter make up as much as 20 percent of the volume.

The B2 horizon is brown (7.5YR 4/2, 4/4, 5/4), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4). It is fine sandy loam, loam, or clay loam. Coarse fragments of sandstone that are less than 10 inches in diameter make up 15 to 30 percent of the volume. The B2 horizon ranges from strongly acid to slightly acid.

The Cr horizon is weathered sandstone in shades of brown.

The Coweta soils are on crests and side slopes and are associated with Bates and Eram soils. Bates and Eram soils have a solum that is more than 20 inches thick. Eram soils have a fine control section.

Dennis series

The Dennis series consists of deep, moderately well drained, slowly permeable, very gently sloping through gently sloping soils on uplands. The soils formed in shale or clayey sediment under a cover of grass.

Typical pedon of Dennis silt loam in an area of Dennis silt loam, 1 to 3 percent slopes, about 2,300 feet north and 2,150 feet west of the southeast corner of sec. 6, T. 25 N., R. 16 E.

A1—0 to 13 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; friable; medium acid; gradual smooth boundary.

B1—13 to 17 inches; dark brown (10YR 3/3) silty clay loam; few fine faint grayish brown and yellowish brown mottles; weak medium subangular blocky

structure; firm; few fine iron-manganese oxide concretions; medium acid; gradual smooth boundary.

B21t—17 to 30 inches; yellowish brown (10YR 5/4) clay; common fine distinct yellowish red (5YR 4/6), brown (10YR 5/3), and gray (10YR 5/1) mottles; moderate fine blocky structure; very firm; continuous clay films on faces of peds; few fine iron-manganese oxide concretions; slightly acid; gradual smooth boundary.

B22t—30 to 48 inches; yellowish brown (10YR 5/4) clay; many coarse distinct gray (10YR 5/1) and many coarse faint yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very firm; continuous clay films on faces of peds; few fine iron-manganese oxide concretions; slightly acid; gradual smooth boundary.

B31—48 to 58 inches; coarsely mottled yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) clay; weak coarse blocky structure; very firm; clay films on faces of peds; few fine iron-manganese oxide concretions; mildly alkaline; gradual smooth boundary.

B32—58 to 78 inches; coarsely mottled gray (10YR 6/1), yellowish brown (10YR 5/6), and dark grayish brown (10YR 4/2) clay; weak coarse blocky structure; very firm; clay films on faces of peds; few iron-manganese oxide concretions; mildly alkaline.

Solum thickness and depth to bedrock are more than 60 inches. A seasonal water table is at a depth of 2 to 3 feet below the surface.

The A1 or Ap horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). If not limed it ranges from strongly acid to medium acid.

The B1 horizon is dark brown (10YR 3/3) or brown (10YR 4/3). It is silty clay loam or clay loam and is mottled in shades of brown, gray, or red. It ranges from strongly acid to medium acid.

The B2t horizon is brown (10YR 4/3) or yellowish brown (10YR 5/4, 5/6). It is silty clay or clay and is mottled in shades of brown, gray, or red. It ranges from strongly acid to slightly acid.

The B3 horizon is coarsely mottled in shades of brown, gray, or red. It is silty clay or clay. It ranges from medium acid to mildly alkaline.

The Dennis soils are in valleys and on side slopes and are associated with Bates, Eram, Okemah, Parsons, and Riverton soils. Bates and Eram soils have a solum that is less than 40 inches thick. Okemah soils typically have a very dark brown, black, or very dark gray A horizon. Parsons soils change abruptly in texture from the A to the B horizon and are typically more gray throughout the solum. Riverton soils are skeletal in the control section.

Enders series

The Enders series consists of deep, well drained, very slowly permeable, sloping soils on uplands. The soils formed in materials that weathered from shale interbedded with thin layers of sandstone under a cover of trees.

Typical pedon of Enders loam, in an area of Enders-Hector association, sloping, about 50 feet east and 100 feet south of the northwest corner of sec. 19, T. 29 N., R. 15 E.

A11—0 to 2 inches; dark brown (10YR 3/3) loam; weak fine granular structure; very friable; few sandstone fragments less than 3 inches in diameter; slightly acid; clear wavy boundary.

A12—2 to 5 inches; brown (10YR 4/3) loam; weak medium granular structure; friable; few sandstone fragments less than 3 inches in diameter; strongly acid; clear wavy boundary.

B1—5 to 8 inches; brown (7.5YR 5/4) loam; few fine faint reddish brown mottles; weak medium subangular blocky structure; friable; strongly acid; gradual wavy boundary.

B2t—8 to 30 inches; yellowish red (5YR 5/6) clay; few fine faint brown mottles; moderate fine blocky structure; firm; clay films on faces of peds; strongly acid; gradual wavy boundary.

B3—30 to 46 inches; coarsely mottled yellowish red (5YR 4/6), reddish brown (5YR 4/4), and pale brown (10YR 6/3) clay; moderate fine blocky structure; firm; common shale fragments; strongly acid; diffuse wavy boundary.

Cr—46 to 62 inches; weathered shale; mottled in shades of gray and brown; slightly acid.

Solum thickness is 32 to 60 inches, and depth to bedrock is 40 to 60 inches.

The A11 horizon is very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), brown (10YR 4/3), or dark grayish brown (10YR 4/2). It ranges from extremely acid to strongly acid and in limed areas it ranges from slightly acid to neutral.

The A12 horizon is brown (10YR 4/3, 5/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4). If not limed, it ranges from very strongly acid to strongly acid.

The B1 horizon is brown (7.5YR 5/4) or yellowish red (5YR 4/6, 5/6, 5/8). It ranges from very strongly acid to strongly acid.

The B2t horizon is yellowish red (5YR 4/6, 5/6) or red (2.5YR 4/6, 5/6). Some pedons have mottles in shades of brown or gray in the lower part. The B2t horizon ranges from very strongly acid to strongly acid.

The B3 horizon is coarsely mottled in shades of red, brown, or gray. It ranges from very strongly acid to strongly acid. There are shale fragments in some pedons.

The Cr horizon is shale in shades of brown, red, or gray.

The Enders soils are on crests and side slopes and are associated with Hector soils. Hector soils have a solum that is less than 20 inches thick.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable, very gently sloping through moderately steep soils on uplands. The soils formed in materials that weathered from shale under a cover of grass.

Typical pedon of Eram silt loam, in an area of Eram-Radley complex, 0 to 8 percent slopes, about 650 feet west and 100 feet south of the northeast corner of sec. 1, T. 25 N., R. 15 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; friable; slightly acid; clear smooth boundary.

B2t—8 to 16 inches; very dark grayish brown (10YR 3/2) silty clay; few fine faint brown mottles; moderate medium blocky structure; very firm; slightly acid; gradual smooth boundary.

B3—16 to 28 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine faint brown mottles; weak coarse blocky structure; firm; neutral; gradual smooth boundary.

Cr—28 to 34 inches; grayish brown weathered soft shale; moderately alkaline.

Solum thickness and depth to shale range from 20 to 40 inches. A seasonal water table is at a depth of 2 to 3 feet below the surface.

The A1 horizon is dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2). It is silt loam or silty clay loam. It ranges from medium acid to slightly acid. There are a few sandstone fragments on the surface in some areas.

The B2t horizon is very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), brown (10YR 4/3, 5/3; 7.5YR 5/4), or yellowish brown (10YR 5/4). It is clay, silty clay, or silty clay loam. It ranges from strongly acid to slightly acid. There are mottles in shades of brown or gray.

The B3 horizon is dark grayish brown (10YR 4/2), brown (10YR 5/4). It is clay, silty clay, or silty clay loam. yellowish brown (10YR 5/4, 5/6). It is clay, silty clay, or silty clay loam. It ranges from medium acid to neutral. There are mottles of brown or gray.

The Cr horizon is soft shale. It is mildly alkaline or moderately alkaline.

The Eram soils are on side slopes and in valleys and are associated with Coweta and Dennis soils. Coweta soils have a solum that is less than 20 inches thick, and Dennis soils have a solum that is more than 60 inches thick.

Hector series

The Hector series consists of shallow, well drained, moderately rapidly permeable, sloping soils on uplands. The soils formed in materials that weathered from sandstone under a cover of trees.

Typical pedon of Hector loam, in an area of Liberal-Hector association, sloping, about 700 feet south and 100 feet east of the northwest corner of sec. 5, T. 25 N., R. 17 E.

A1—0 to 3 inches; dark brown (10YR 3/3) loam; moderate medium granular structure; very friable; few sandstone fragments; slightly acid; clear smooth boundary.

A2—3 to 6 inches; brown (10YR 4/3) loam; moderate medium granular structure; very friable; few sandstone fragments; strongly acid; clear smooth boundary.

B2—6 to 14 inches; yellowish brown (10YR 5/4) loam; weak coarse subangular blocky structure; friable; few sandstone fragments; strongly acid; abrupt wavy boundary.

R—14 to 16 inches; yellowish brown (10YR 5/6) hard fractured sandstone.

Solum thickness and depth to sandstone bedrock range from 10 to 20 inches.

The A1 horizon is dark brown (10YR 3/3), brown (10YR 4/3), or dark grayish brown (10YR 4/2). It is loam or fine sandy loam. It ranges from strongly acid to slightly acid. Sandstone fragments make up 2 to 35 percent of the volume.

The A2 horizon is brown (10YR 4/3, 5/3), grayish brown (10YR 5/3), or dark yellowish brown (10YR 4/4). It is loam or fine sandy loam. It ranges from strongly acid to slightly acid. Sandstone fragments make up 2 to 35 percent of the volume.

The B2 horizon is yellowish brown (10YR 5/4, 5/6), brown (10YR 5/3; 7.5YR 5/4), or strong brown. It is loam or fine sandy loam. It ranges from very strongly acid to strongly acid. Sandstone fragments make up 2 to 35 percent of the volume.

The Hector soils are on crests and side slopes and are associated with Enders and Liberal soils. Enders and Liberal soils have a clayey control section.

Kanima series

The Kanima series consists of deep, well drained, moderately to moderately rapidly permeable, very gently sloping through sloping soils on uplands. The soils formed in materials that weathered from shale and limestone under a cover of grass.

Typical pedon of Kanima very shaly silt loam, in an area of Kanima very shaly silt loam, 1 to 8 percent

slopes, about 1,600 feet south and 200 feet west of the northeast corner of sec. 1, T. 25 N., R. 17 E.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) very shaly silt loam; massive; friable; 60 percent shale fragments; mildly alkaline; diffuse wavy boundary.

C—4 to 70 inches; very dark grayish brown (10YR 3/2) very shaly silt loam; massive; friable; 80 percent shale fragments; few pockets of very dark grayish brown (10YR 3/2) clay that have clay films on faces of peds; mildly alkaline.

The A1 horizon is very dark grayish brown (10YR 3/2; 2.5Y 3/2) or dark grayish brown (10YR 4/2; 2.5Y 4/2). It is shaly or very shaly silt loam. Shale or limestone fragments that are less than 3 inches in diameter make up 45 to 70 percent of the volume. Shale or limestone fragments that are more than 3 inches in diameter make up 0 to 5 percent. This horizon ranges from neutral to moderately alkaline.

The C horizon is very dark grayish brown (10YR 3/2; 2.5Y 3/2), dark grayish brown (10YR 4/2; 2.5Y 4/2), or brown (10YR 4/3). It has fragments of silty clay, clay, or silty clay loam in shades of brown. Shale or limestone fragments that are less than 3 inches in diameter make up 45 to 85 percent of the volume. Shale or limestone fragments that are more than 3 inches in diameter make up 5 to 30 percent. This horizon ranges from neutral to moderately alkaline.

The Kanima soils are in coal strip mines and on crests and side slopes and are associated with Apperson, Claremore, and Shidler soils. The associated soils do not have a loamy-skeletal control section.

Kiti series

The Kiti series consists of shallow, well drained, moderately permeable, very gently sloping through sloping soils on uplands. The soils formed in materials that weathered from limestone under a cover of grass.

Typical pedon of Kiti silty clay loam, in an area of Shidler-Kiti-Limestone outcrop complex, 1 to 8 percent slopes, about 2,300 feet west and 100 feet north of the southeast corner of sec. 16, T. 26 N., R. 17 E.

A11—0 to 7 inches; very dark brown (10YR 2/2) channery silty clay loam; strong medium granular structure; friable; 10 percent by volume flat limestone fragments less than 3 inches in length and 35 percent by volume flat limestone fragments 3 to 15 inches in length; neutral; gradual wavy boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) very channery silty clay loam; strong medium granular structure; friable; 5 percent by volume flat limestone fragments less than 3 inches in length and 60 percent by volume flat limestone fragments 3 to 15 inches in length; mildly alkaline; abrupt irregular boundary.

R—13 to 15 inches; hard fractured limestone.

Solum thickness and depth to limestone bedrock range from 4 to 20 inches.

The A horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3). It is silty clay loam or silt loam. It ranges from neutral to moderately alkaline. Flat fragments of limestone or dolomite that are less than 3 inches in length make up 5 to 10 percent of the volume. Flat fragments of limestone or dolomite that are 3 to 15 inches in length make up 30 to 60 percent.

The Kiti soils are on crests and side slopes and are associated with Shidler soils and Limestone outcrop. Shidler soils do not have a loamy-skeletal control section.

Liberal series

The Liberal series consists of deep, moderately well drained, slowly permeable, sloping soils on uplands. The soils formed in material that weathered from shale under a cover of grass and trees.

Typical pedon of Liberal silty clay loam, in an area of Liberal-Hector association, sloping, about 500 feet north and 100 feet east of the southwest corner of sec. 32, T. 26 N., R. 17 E.

A1—0 to 7 inches; very dark grayish brown (2.5Y 3/2) silty clay loam; moderate fine granular structure; firm; medium acid; gradual smooth boundary.

B1—7 to 12 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

B21t—12 to 16 inches; grayish brown (2.5Y 5/2) clay; few fine faint light olive brown mottles; moderate fine blocky structure; firm; medium acid; gradual smooth boundary.

B22t—16 to 28 inches; grayish brown (2.5Y 5/2) clay; few fine faint olive brown mottles; weak medium blocky structure; very firm; clay films on faces of peds; few shale fragments; slightly acid; gradual smooth boundary.

B3—28 to 35 inches; grayish brown (2.5Y 5/2) clay; few fine faint light olive brown mottles; weak coarse blocky structure; very firm; common shale fragments; neutral; gradual smooth boundary.

C—35 to 45 inches; grayish brown (2.5Y 5/2) weathered shale and clay; massive; very firm; neutral; gradual smooth boundary.

Cr—45 to 60 inches; grayish brown (2.5Y 5/2) soft shale; neutral.

The solum is 20 to 40 inches thick. Depth to shale bedrock ranges from 40 to 60 inches. In some areas

there are a few sandstone or siltstone fragments on the surface and throughout the pedon. A seasonal water table is at a depth of 2 to 3 feet below the surface.

The A1 or Ap horizon is very dark grayish brown (10YR 3/2; 2.5Y 3/2). If not limed, it is medium acid.

The B1 horizon is brown (10YR 4/3, 5/3), yellowish brown (10YR 5/4), or light olive brown (2.5Y 5/4). It ranges from strongly acid to medium acid.

The B2t horizon is brown (10YR 5/3), yellowish brown (10YR 5/4), light olive brown (2.5Y 5/4), dark grayish brown (10YR 4/2; 2.5Y 4/2), or grayish brown (10YR 5/2; 2.5Y 5/2). It has mottles in shades of brown, gray, or red. The B2t horizon is clay, silty clay, or silty clay loam. It ranges from strongly acid to medium acid.

The B3 horizon is grayish brown (10YR 5/2; 2.5Y 5/2) or dark grayish brown (10YR 4/2; 2.5Y 4/2) and has mottles in shades of brown or gray. It is clay, silty clay, or silty clay loam. It ranges from medium acid to neutral.

The C horizon is a mixture of weathered shale and clay or soft shale. The Cr horizon is soft shale bedrock.

Liberal soils are on side slopes and crests. They are associated with Hector, Shidler, and Summit soils. Hector and Shidler soils have a solum that is less than 20 inches thick, and Summit soils have a solum that is more than 60 inches thick.

Mason series

The Mason series consists of deep, moderately well drained, moderately slowly permeable, nearly level soils on flood plains. The soils formed in material that weathered from loamy sediment under a cover of grass and trees. They are rarely flooded.

Typical pedon of Mason silt loam, about 2,500 feet north and 1,950 feet west of the southeast corner of sec. 3, T. 27 N., R. 16 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; weak fine granular structure; friable; neutral; clear smooth boundary.

A1—7 to 18 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; friable; neutral; gradual smooth boundary.

B21t—18 to 32 inches; very dark grayish brown (10YR 3/2) silt loam; weak coarse subangular blocky structure; friable; clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—32 to 45 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate medium subangular blocky structure; firm; clay films on faces of peds; few fine iron-manganese oxide concretions; medium acid; gradual smooth boundary.

B3—45 to 64 inches; dark grayish brown (10YR 4/2) silty clay loam; weak medium subangular blocky structure; firm; few fine iron-manganese oxide concretions; medium acid.

The mollic epipedon is more than 20 inches thick. The solum is more than 40 inches thick.

The Ap or A1 horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). It ranges from strongly acid to neutral.

The B2t or B3 horizon is very dark grayish brown (10YR 3/2), dark brown (10YR 3/3; 7.5YR 3/2), dark grayish brown (10YR 4/2), brown (10YR 4/3; 7.5YR 4/2, 4/4), or dark yellowish brown (10YR 3/4, 4/4). It is silty clay loam, silt loam, or clay loam. It ranges from strongly acid to medium acid.

Mason soils are on narrow flood plains. They are associated with Wynona and Radley soils. Wynona soils have an aquic moisture regime. Radley soils do not have an argillic horizon.

Nowata series

The Nowata series consists of moderately deep, well drained, moderately slowly permeable, very gently sloping through gently sloping soils on uplands. The soils formed in materials that weathered from cherty limestone under a cover of grass.

Typical pedon of Nowata silt loam, in an area of Nowata silt loam, 2 to 5 percent slopes, about 1,600 feet south and 600 feet east of the northwest corner of sec. 23, T. 28 N., R. 16 E.

A1—0 to 12 inches; dark brown (7.5YR 3/2) silt loam; moderate medium granular structure; friable; 5 percent by volume rounded cherty fragments less than 3 inches in diameter; slightly acid; gradual smooth boundary.

B1—12 to 18 inches; brown (7.5YR 4/2) silt loam; weak medium subangular blocky structure parting to moderate medium granular; friable; 15 percent by volume rounded cherty fragments less than 3 inches in diameter; slightly acid; gradual smooth boundary.

B21t—18 to 29 inches; reddish brown (5YR 4/3) very gravelly silty clay loam; moderate medium subangular blocky structure obscured by gravel; firm; clay films on faces of peds and in pores; 70 percent by volume rounded cherty fragments less than 3 inches in diameter; slightly acid; gradual wavy boundary.

B22t—29 to 36 inches; reddish brown (5YR 4/4) very gravelly silty clay loam; weak fine subangular blocky structure obscured by gravel; firm; clay films on faces of peds and in pores; 70 percent by volume rounded cherty fragments less than 3 inches in diameter; neutral; abrupt wavy boundary.

R—36 to 38 inches; hard limestone bedrock.

The solum thickness and depth to hard limestone bedrock range from 20 to 40 inches.

The A1 or Ap horizon is dark brown (10YR 3/3; 7.5YR 3/2), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2). Gravel or cherty fragments that are

less than 3 inches in diameter make up as much as 10 percent of the volume. Coarse fragments that are more than 3 inches in diameter make up 10 percent. This horizon ranges from medium acid to neutral.

The B1 horizon is dark brown (10YR 3/3; 7.5YR 3/2), very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), brown (7.5YR 4/2, 4/4), or dark reddish brown (5YR 2/2, 3/2, 3/3, 3/4). It is silt loam or silty clay loam or the gravelly, coarse cherty, or cherty counterparts. Gravel or cherty fragments that are less than 3 inches in diameter make up 5 to 50 percent of the volume. Coarse fragments that are more than 3 inches in diameter make up 20 percent. The B1 horizon ranges from medium acid to neutral.

The B2t horizon is dark brown (7.5YR 3/2), brown (7.5YR 4/2, 4/4, 5/4), dark reddish brown (5YR 3/2, 3/4; 2.5YR 3/4), reddish brown (5YR 4/3, 4/4; 2.5YR 4/4), or yellowish red (5YR 4/6, 4/8). It is the gravelly, very gravelly, cherty, coarse cherty, or very cherty counterparts of silty clay loam. Gravel or cherty fragments that are less than 3 inches in diameter make up 35 to 85 percent of the volume. Coarse fragments that are more than 3 inches in diameter make up 0 to 50 percent. Some pedons have mottles in shades of brown, yellow, or red. This horizon ranges from medium acid to neutral.

The Nowata soils are on broad crests and side slopes and are associated with Catoosa and Summit soils. Catoosa and Summit soils do not have a skeletal control section.

Okemah series

The Okemah series consists of deep, moderately well drained, slowly permeable, nearly level soils on uplands. The soils formed in materials that weathered from shale, clayey sediment, or loamy sediment under a cover of grass.

Typical pedon of Okemah silt loam in an area of Okemah silt loam, 0 to 1 percent slopes, about 2,600 feet west and 100 feet north of the southeast corner of sec. 23, T. 25 N., R. 15 E.

A1—0 to 12 inches; very dark brown (10YR 2/2) silt loam; moderate medium granular structure; friable; slightly acid; diffuse smooth boundary.

A3—12 to 18 inches; very dark brown (10YR 2/2) silty clay loam; few fine faint grayish brown and yellowish brown mottles; moderate medium granular structure; firm; neutral; gradual wavy boundary.

B21t—18 to 30 inches; very dark gray (10YR 3/1) silty clay; common fine faint brown mottles; weak medium blocky structure; very firm; clay films on faces of peds; mildly alkaline; gradual smooth boundary.

B22t—30 to 56 inches; dark grayish brown (10YR 4/2) silty clay; many coarse faint or distinct dark yellowish brown (10YR 4/4), olive brown (2.5Y 4/4), and brown (7.5YR 4/4) mottles; weak medium blocky structure; very firm; clay films on faces of peds; few fine iron-manganese oxide concretions; few calcium carbonate concretions; mildly alkaline; gradual smooth boundary.

B3—56 to 72 inches; coarsely mottled gray (10YR 5/1), light gray (10YR 6/1), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) silty clay; weak coarse blocky structure; very firm; moderately alkaline.

The solum is more than 60 inches thick. A seasonal water table is at a depth of 24 to 36 inches below the surface.

The Ap or A1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It ranges from medium acid to neutral.

The A3 or B1 horizon, where present, has colors similar to those in the A1 horizon. It is silt loam or silty clay loam. It ranges from medium acid to neutral.

The B2t horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2; 2.5Y 3/2), dark gray (10YR 4/1), or dark grayish brown (10YR 4/2; 2.5Y 4/2). It has mottles in shades of gray, brown, or red. The B2t horizon is silty clay or clay. It ranges from medium acid to mildly alkaline.

The B3 horizon is coarsely mottled in shades of gray, brown, or red. It is silty clay or clay. It ranges from neutral to moderately alkaline.

The Okemah soils are in broad valleys and are associated with Dennis and Parsons soils. Dennis soils do not have chroma of 1 to 2 in the B2t horizon. Parsons soils have an aquic moisture regime.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable, nearly level soils on flood plains. The soils formed in material that weathered from clayey sediment under a cover of grass and trees. They are flooded occasionally.

Typical pedon of Osage clay, about 2,100 feet north and 150 feet east of the southwest corner of sec. 7, T. 26 N., R. 17 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay; moderate fine granular structure; firm; slightly acid; clear smooth boundary.

A1—7 to 18 inches; very dark gray (10YR 3/1) clay; few fine faint brown mottles; moderate fine blocky structure; very firm; slightly darker colored faces of peds; slightly acid; gradual smooth boundary.

B21g—18 to 35 inches; very dark gray (10YR 3/1) clay; few fine faint brown mottles; moderate fine blocky structure; very firm; slightly darker colored faces of peds; slightly acid; diffuse smooth boundary.

B22g—35 to 48 inches; very dark gray (10YR 3/1) clay; few fine faint brown and grayish brown mottles; weak very fine blocky structure; very firm; shiny ped faces; slightly acid; diffuse smooth boundary.

B3g—48 to 76 inches; very dark gray (10YR 3/1) in upper part and dark gray (10YR 4/1) in lower part, clay; few fine faint brown and grayish brown mottles; weak fine blocky structure; very firm; shiny ped faces; neutral.

The solum is more than 40 inches thick. A seasonal water table is at a depth of as much as 12 inches below the surface.

The A1 or Ap horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It ranges from medium acid to neutral.

The B2g or B3g horizon is very dark gray (10YR 3/1; N 3/0) or dark gray (10YR 4/1; N 4/0). It ranges from medium acid to neutral in the upper part and from slightly acid to mildly alkaline in the lower part.

The Osage soils are on flood plains and are associated with Wynona soils. Wynona soils have a fine-silty control section.

Parsons series

The Parsons series consists of deep, somewhat poorly drained, very slowly permeable, nearly level through very gently sloping soils on uplands. The soils formed in materials that weathered from shale and clayey sediment under a cover of grass.

Typical pedon of Parsons silt loam, in an area of Parsons silt loam, 1 to 3 percent slopes, about 400 feet west and 100 feet north of the southeast corner of sec. 6, T. 25 N., R. 16 E.

A1—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam; weak medium granular structure; friable; few fine iron-manganese oxide concretions; medium acid; gradual smooth boundary.

A2—9 to 15 inches; dark grayish brown (10YR 4/2) silt loam; few fine faint brown mottles; weak medium granular structure; friable; few fine iron-manganese oxide concretions; medium acid; abrupt wavy boundary.

B21tg—15 to 25 inches; grayish brown (10YR 5/2) clay; common medium distinct light gray (10YR 6/1) and reddish brown (5YR 4/4) mottles; weak coarse blocky structure parting to weak fine blocky; very firm; clay films on faces of peds; few fine iron-manganese oxide concretions; medium acid; gradual smooth boundary.

B22tg—25 to 40 inches; gray (10YR 5/1) clay; many coarse faint and distinct light gray (10YR 6/1), grayish brown (10YR 5/2), brown (10YR 5/3), or yellowish brown (10YR 5/4, 5/6) mottles; weak coarse blocky structure; very firm; clay films on faces of peds; few fine and medium iron-manganese oxide concretions; slightly acid; gradual smooth boundary.

B3—40 to 74 inches; coarsely mottled gray (10YR 6/1) and yellowish brown (10YR 5/6, 5/4) clay; weak coarse blocky structure; very firm; few fine iron-manganese oxide concretions; mildly alkaline.

The solum is more than 40 inches thick. A seasonal water table is at a depth of 6 to 18 inches below the surface.

The A1 or Ap horizon ranges from strongly acid to slightly acid.

The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). It ranges from strongly acid to medium acid.

The B2tg horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2; 2.5Y 4/2), dark gray (10YR 4/1), dark grayish brown (10YR 4/2; 2.5Y 4/2), gray (10YR 5/1), or grayish brown (10YR 5/2; 2.5Y 5/2). It has mottles in shades of gray, brown, or red. The B2tg horizon ranges from strongly acid to slightly acid.

The B3g horizon has colors similar to those in the B2tg horizon, or it has mottles in shades of gray or brown. It ranges from medium acid to mildly alkaline.

The Parsons soils are in broad valleys and are associated with Dennis and Okemah soils. Dennis and Okemah soils do not have an aquic moisture regime.

Radley series

The Radley series consists of deep, moderately well drained, moderately permeable, nearly level soils on flood plains. The soils formed in material that weathered from loamy sediment under a cover of trees and grass. They are flooded occasionally or frequently.

Typical pedon of Radley silt loam, in an area of Eram-Radley complex, 0 to 8 percent slopes, about 700 feet west and 100 feet south of the northeast corner of sec. 1, T. 25 N., R. 15 E.

A1—0 to 18 inches; dark brown (10YR 3/3) silt loam; weak medium granular structure; friable; slightly acid; gradual smooth boundary.

B2—18 to 30 inches; brown (10YR 4/3) silt loam; weak medium granular structure; friable; slightly acid; gradual smooth boundary.

C—30 to 45 inches; brown (10YR 4/3) silt loam; massive; friable; few fine strata of darker and lighter colored material; slightly acid; clear smooth boundary.

Ab—45 to 60 inches; very dark grayish brown (10YR 3/2) silt loam; massive; friable; slightly acid.

The A1 or Ap horizon is dark brown (10YR 3/3; 7.5YR 3/2) or very dark grayish brown (10YR 3/2). It ranges from medium acid to slightly acid.

The B2 horizon is brown (10YR 4/3, 5/3), dark grayish brown (10YR 4/2), or grayish brown (10YR 5/2). It is silt loam or silty clay loam. It ranges from medium acid to slightly acid.

The C horizon is brown (10YR 5/3, 4/3), grayish brown (10YR 5/2), or dark grayish brown (10YR 4/2). It is silt loam or silty clay loam with thin strata of lighter and darker colored material. It ranges from medium acid to slightly acid.

The Ab horizon, where present, is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). It is silt loam or silty clay loam. It ranges from medium acid to neutral.

The Radley soils are on narrow flood plains and are associated with Mason and Wynona soils. Mason soils have an argillic horizon, and Wynona soils have an aquic moisture regime and grayer colors.

Riverton series

The Riverton series consists of deep, well drained, moderately permeable, very gently sloping soils on uplands. The soils formed in material that weathered from gravelly loamy or loamy sediment under a cover of grass and trees.

Typical pedon of Riverton loam, in an area of Riverton loam, 1 to 3 percent slopes, about 2,100 feet south and 750 feet west of the northeast corner of sec. 8, T. 28 N., R. 16 E.

A1—0 to 9 inches; dark brown (7.5YR 3/2) loam; weak medium granular structure; friable; about 6 percent gravel by volume; slightly acid; gradual smooth boundary.

B1—9 to 15 inches; reddish brown (5YR 4/4) gravelly clay loam; moderate coarse subangular blocky structure; friable; about 15 percent gravel by volume; medium acid; gradual smooth boundary.

B21t—15 to 30 inches; reddish brown (5YR 5/4) very gravelly clay loam; moderate medium subangular blocky structure; firm; about 55 percent gravel by volume; clay films on faces of peds and on pebbles; medium acid; gradual wavy boundary.

B22t—30 to 55 inches; yellowish red (5YR 4/6) very gravelly clay loam; weak medium subangular blocky structure largely obscured by gravel; firm; clay films on faces of peds and on pebbles; about 65 percent gravel by volume; strongly acid; diffuse smooth boundary.

B3—55 to 80 inches; yellowish red (5YR 4/6) very gravelly clay loam; weak medium subangular blocky structure largely obscured by gravel; firm; about 65 percent gravel by volume; strongly acid.

The solum is more than 60 inches thick.

The A1 or Ap horizon ranges from strongly acid to slightly acid.

The B1 horizon is dark reddish brown (5YR 3/3, 3/4) or reddish brown (5YR 4/4). It is gravelly clay loam or gravelly loam. It ranges from strongly acid to medium acid.

The B21t horizon is dark reddish brown (5YR 3/4), reddish brown (5YR 4/4, 5/4), or red (2.5YR 4/6). It is gravelly clay loam, very gravelly clay loam, or very gravelly silty clay loam. It ranges from strongly acid to medium acid.

The B22t or B3 horizon is yellowish red (5YR 4/6, 5/6) or red (2.5YR 4/6, 5/6). The B3 horizon also is strong brown (7.5YR 5/6). It is very gravelly clay loam or very gravelly silty clay loam. It ranges from very strongly acid to strongly acid.

The Riverton soils are on crests and side slopes and are associated with Dennis soils. Dennis soils have a fine control section.

Shidler series

The Shidler series consists of shallow, well drained, moderately permeable, very gently sloping through sloping soils on uplands. The soils formed in materials that weathered from limestone under a cover of grass.

Typical pedon of Shidler silt loam, in an area of Shidler-Claremore complex, 1 to 3 percent slopes, about 400 feet south and 100 feet east of the northwest corner of sec. 27, T. 28 N., R. 17 E.

A1—0 to 13 inches; very dark brown (10YR 2/2) silt loam; moderate medium granular structure; friable; few limestone fragments as much as 15 inches in diameter; neutral; abrupt wavy boundary.

R—13 to 15 inches; hard fractured limestone.

The solum thickness and depth to hard limestone range from 4 to 20 inches.

The A1 horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (7.5YR 3/2; 10YR 3/3). It is silt loam or silty clay loam. It ranges from slightly acid to mildly alkaline. Rock fragments of limestone that range from 15 to 36 inches in diameter make up 0 to 20 percent of the volume. Fragments that range from 3 to 15 inches in diameter make up 30 percent of the volume, and fragments that are less than 3 inches in diameter also make up as much as 30 percent.

The Shidler soils are on crests and side slopes and are associated with Catoosa, Claremore, Kanima, Kiti, and Liberal soils. Catoosa, Claremore, and Liberal soils have an argillic horizon. Kanima and Kiti soils have a loamy-skeletal control section.

Summit series

The Summit series consists of deep, moderately well drained, slowly permeable, gently sloping soils on up-

lands. The soils formed in materials that weathered from loamy or clayey sediment under a cover of grass.

Typical pedon of Summit silty clay loam, 3 to 5 percent slopes, about 400 feet north and 100 feet west of the southeast corner of sec. 21, T. 25 N., R. 17 E.

A1—0 to 11 inches; very dark brown (10YR 2/2) silty clay loam; moderate medium granular structure; friable; slightly acid; gradual smooth boundary.

B1—11 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

B21t—18 to 26 inches; very dark grayish brown (2.5Y 3/2) silty clay; few fine distinct dark yellowish brown mottles; moderate fine blocky structure; very firm; clay films on faces of peds; slightly acid; gradual wavy boundary.

B22t—26 to 48 inches; olive brown (2.5Y 4/4) silty clay; few fine faint yellowish brown mottles; moderate fine blocky structure; very firm; clay films on faces of peds; few fine iron-manganese oxide concretions; neutral; diffuse smooth boundary.

B3—48 to 80 inches; olive brown (2.5Y 4/4) silty clay; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) mottles; weak coarse blocky structure; very firm; few shale fragments; neutral.

The solum thickness ranges from 50 to more than 60 inches, and depth to bedrock is more than 60 inches. A seasonal water table is at a depth of 24 to 36 inches below the surface.

The A1 or B1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2; 2.5Y 3/2). It ranges from medium acid to slightly acid.

The B21t horizon is very dark grayish brown (10YR 3/2; 2.5Y 3/2), dark grayish brown (10YR 4/2; 2.5Y 4/2), dark yellowish brown (10YR 4/4), or olive brown (2.5Y 4/4). It ranges from medium acid to neutral.

The B22t or B3 horizon is brown (10YR 4/3), dark yellowish brown (10YR 4/4), or olive brown (2.5Y 4/4). It ranges from slightly acid to mildly alkaline.

The Summit soils are on side slopes of uplands and are associated with Apperson, Catoosa, Claremore, Kanima, Liberal, and Nowata soils. Apperson, Catoosa, Claremore, Liberal, and Nowata soils have a thinner solum. Kanima soils have a loamy-skeletal control section.

Wynona series

The Wynona series consists of deep, somewhat poorly drained, slowly permeable, nearly level soils on flood plains. The soils formed in loamy sediment under a cover of trees and grass. They are flooded occasionally.

Typical pedon of Wynona silty clay loam, about 2,000 feet south and 150 feet west of the northeast corner of sec. 7, T. 26 N., R. 16 E.

A11—0 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate medium granular structure; friable; slightly acid; diffuse smooth boundary.

A12—12 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam; few fine faint brown mottles; moderate fine granular structure; firm; slightly acid; gradual smooth boundary.

B2g—20 to 42 inches; very dark gray (10YR 3/1) silty clay loam; few fine faint and distinct dark yellowish brown and dark gray mottles; weak medium subangular blocky structure parting to moderate fine granular; firm; medium acid; gradual smooth boundary.

B3g—42 to 65 inches; dark gray (10YR 4/1) silty clay; common medium distinct and faint dark yellowish brown (10YR 4/4) and gray (10YR 5/1) mottles; weak medium blocky structure; firm; few fine iron-manganese oxide concretions; medium acid.

The solum is more than 40 inches thick.

A seasonal water table is at a depth of 0 to 2 feet below the surface.

The A1 or Ap horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It ranges from medium acid to slightly acid.

The B2g horizon has colors and reaction similar to those in the A1 horizon.

The B3g horizon is very dark gray (10YR 3/1), dark gray (10YR 4/1), or very dark grayish brown (10YR 3/2). It is silty clay or silty clay loam. It ranges from strongly acid to slightly acid.

The Wynona soils are on flood plains and are associated with Mason, Osage, and Radley soils. Mason and Radley soils do not have an aquic moisture regime and are less gray. Osage soils have a fine control section.

Formation of the soils

In this section, the processes of soil formation are discussed and related to the soils in the survey area.

Factors of soil formation

The properties of a soil at any given place are the result of the interaction of five major factors of soil formation—parent material, climate, plant and animal life, relief, and time. Few generalizations can be made regarding the effects of any one factor because the effect of each is modified by the effects of the other four.

Parent material

Parent material is one of the most influential factors of soil formation in the county. It sets the limits of the chemical and mineral composition of the soil, and it influences the rate of soil development. Parent material is the unconsolidated material from which soil is formed.

Nowata County has several kinds of parent material, each of which produces a different kind of soil. Soils that formed in material weathered from shale, such as Eram soils, have a clayey subsoil. Those that formed in material weathered from sandstone, such as Hector soils, have a loamy subsoil. Soils that formed in material weathered from limestone, such as Kiti soils, have an adequate supply of bases. Soils that formed in clayey and loamy sediments include the Osage, Radley, and Riverton soils.

Climate

The subhumid continental climate of Nowata County is characterized by periods of intense rainfall. Moisture and warm temperatures have promoted the formation of distinct horizons in many of the soils. Differences among soils, however, cannot be attributed to climate because the climate is uniform throughout the county. Heavy rains, nevertheless, cause rapid runoff that erodes many of the soils.

Plants and animals

Plants, burrowing animals, insects, and micro-organisms in the soil have a direct influence on the formation of soil. Native vegetation, such as trees or grasses or a combination of both, has a bearing on the amount of organic matter and on the amount and kind of plant nutrients in the soil and on the structure and consistence of the soil. Dennis and Okemah soils, for example, formed under native grasses. The deep, fibrous roots of these native grasses recycle soil nutrients and promote a granular structure and a high content of organic-matter. The soils that formed under grass in Nowata County tend to have more bases and organic matter than the soils that formed under trees. Enders and Hector soils formed under trees and are lower in plant nutrients and organic matter than soils that formed under grass.

Relief

Relief affects soil formation through its influence on moisture, drainage, erosion, temperature, and plant cover. The relief of Nowata County is determined largely by the resistance of underlying parent material to weathering and geological erosion.

The effects of relief on soil formation in the county are illustrated by Catoosa and Kiti soils, which formed in material that weathered from limestone under a cover of grasses. Catoosa soils generally are less sloping than Kiti soils. Surface runoff is less, and more water percolates through to influence the loss, gain, or transfer of soil constituents. Kiti soils typically are more sloping and have a less clearly defined profile than Catoosa soils. More rainwater runs off the surface instead of moving through the soil to help in the formation of a deeper solum.

Time

Time as a factor cannot be measured strictly in years. The length of time needed for the development of genetic horizons depends on the combined effects of the other soil-forming factors. Young or immature soils do not have definite horizons. Mature soils have approached equilibrium with their environment and tend to have well defined horizons.

The soils of Nowata County range from immature to mature. Dennis and Okemah soils, on uplands, are mature. Bates and Liberal soils are younger but have clearly defined horizons. Kiti soils are young soils; they have had sufficient time to develop clearly defined horizons but because they are sloping, geological erosion has taken away soil material almost as fast as it has formed. Radley and Wynona soils, on flood plains, have been developing for such a short time that they show little horizon development.

Processes of soil formation

Processes that have influenced the formation of horizons in the soils of Nowata County are accumulation of organic matter, leaching of calcium carbonates and bases, and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in the development of horizons.

The addition of organic matter to the surface layer by native grasses has contributed to the granular structure. The surface layer is high in content of organic matter in soils such as Dennis soils and is called a mollic epipedon in the soil classification system. Hector soils formed under trees and contain less organic matter than Dennis soils; their surface layer is called an ochric epipedon.

Leaching of carbonates and bases is active in the formation of soils. The accumulation of calcium carbonates and bases in the lower part of the B horizon of Catoosa soils indicates the depth to which water has percolated. Enders soils have been leached to the extent that they lack accumulation of calcium carbonates. Bases have been leached from the B horizon of these soils, and this is reflected by their base saturation. Soils on flood plains, such as Radley and Osage soils, are recharged with bases when flooding occurs. Shidler soils formed over limestone beds and are high in carbonates. Calcium carbonates in Shidler soils are related to the nature of the plant materials.

The translocation of silicate clay minerals is a very important factor in establishing the properties and classification of soils. Clay films on ped surfaces, bridging

sand grains, and increases in total clay content are used in the field as evidence of argillic horizons. Many soils, including Dennis, Okemah, and Parsons soils, have an argillic horizon. The varying degrees of translocation of silicate clay minerals and the kind of parent material in which a soil formed have resulted in wide variations in the texture and other properties of the argillic horizon in different soils. Enders and Liberal soils have a surface layer that is more intensely leached of silicate clay minerals than the surface layer of Kiti and Shidler soils.

Grasses bring bases to the surface, and this retards leaching and the formation of an A2 horizon. Geologic erosion on soils such as Kiti soils hinders horizon development. The sediment in which Radley and Wynona soils and other soils on flood plains formed was deposited so recently that there has not been enough time for the formation of horizons.

References

(1) American Association of State Highway and Transportation Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. Supplements replacing pp. 173-188 issued May 1962 .

(4) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 40-inch profile or to a limiting layer is expressed as—

	Inches
Low	0 to 4
Medium	4 to 6
High	More than 6

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer

within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky

structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characterisitc that affects management. These differencees are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is

measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Saprolite (geology). Soft, earthy, clay-rich, thoroughly decomposed rock formed in place by chemical weathering of igneous and metamorphic rock. In soil survey, the term saprolite is applied to any unconsolidated residual material underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance

divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Slow refill. The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

ILLUSTRATIONS

Figure 1.—Cultivation reduces the amount of weeds and improves the intake of water in this area of Dennis silt loam, 1 to 3 percent slopes.

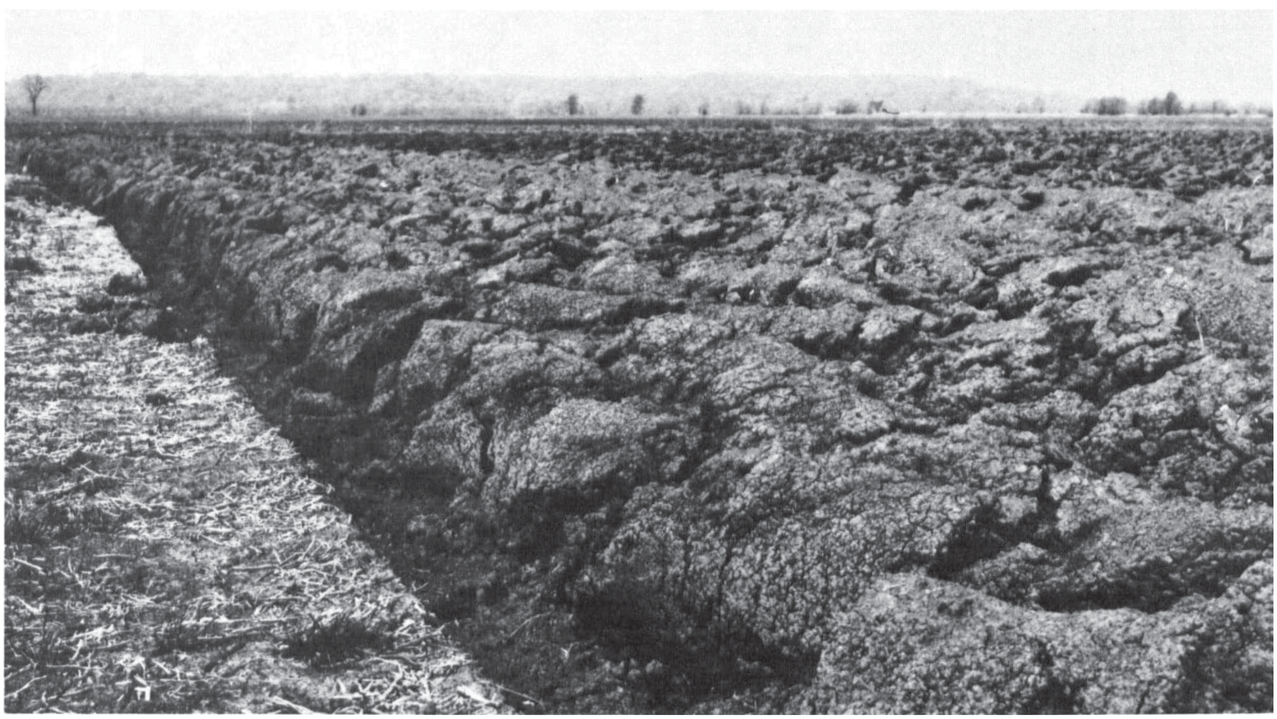


Figure 2.—This field on Osage clay has been prepared for wheat.

Figure 3.—The crop residue on the surface helps protect this area of Parsons silt loam, 1 to 3 percent slopes, from erosion.

Figure 4.—Okemah silt loam, 0 to 1 percent slopes, is suited to fescue.

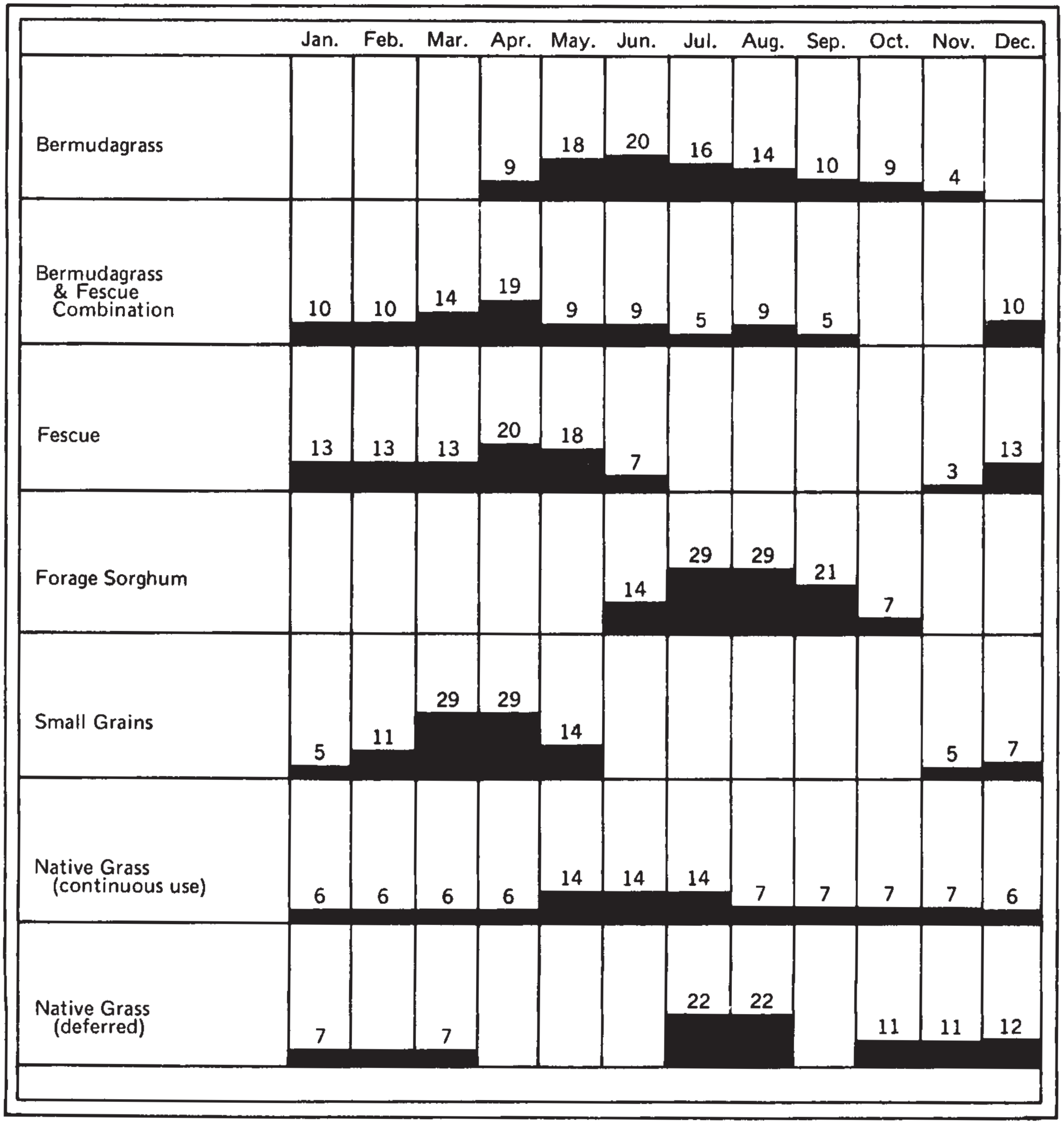


Figure 5.—Forage calendar.

Figure 6.—A typical area of Shidler-Kiti-Limestone outcrop complex, 1 to 8 percent slopes. The range sites are Very Shallow and Edge Rock.

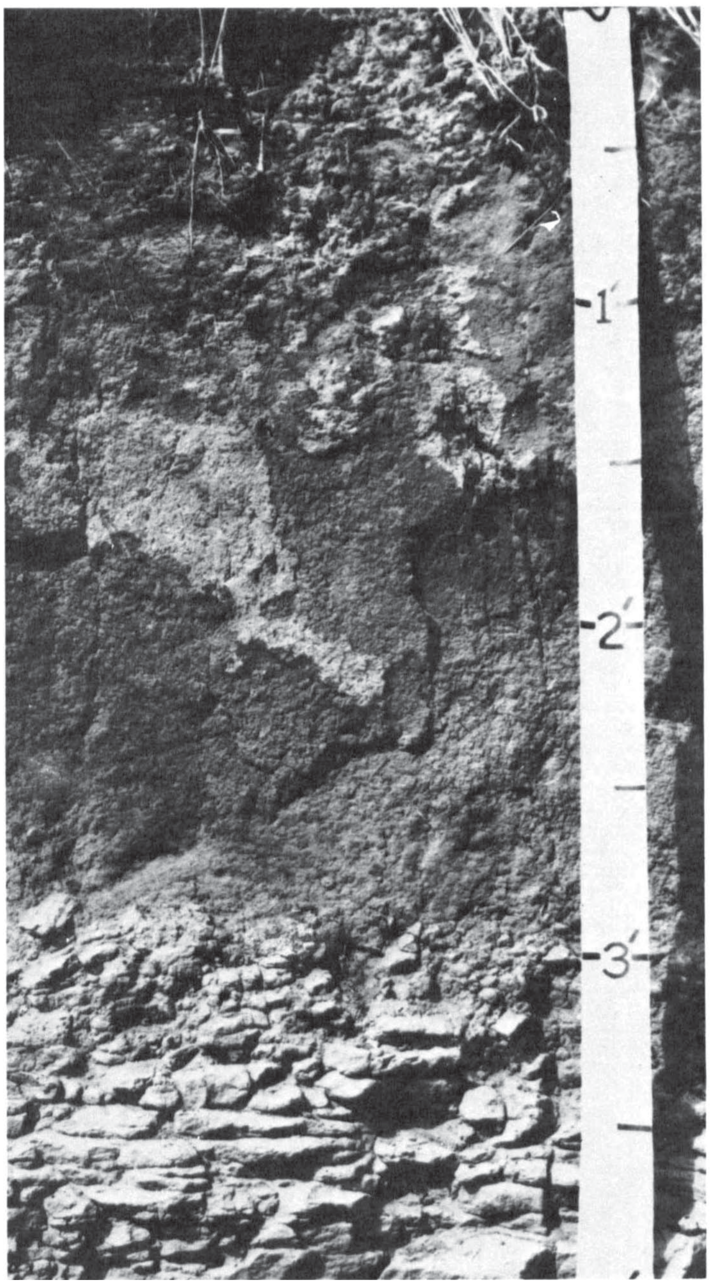


Figure 7.—Profile of a Bates soil. Sandstone is at a depth of 3 feet.

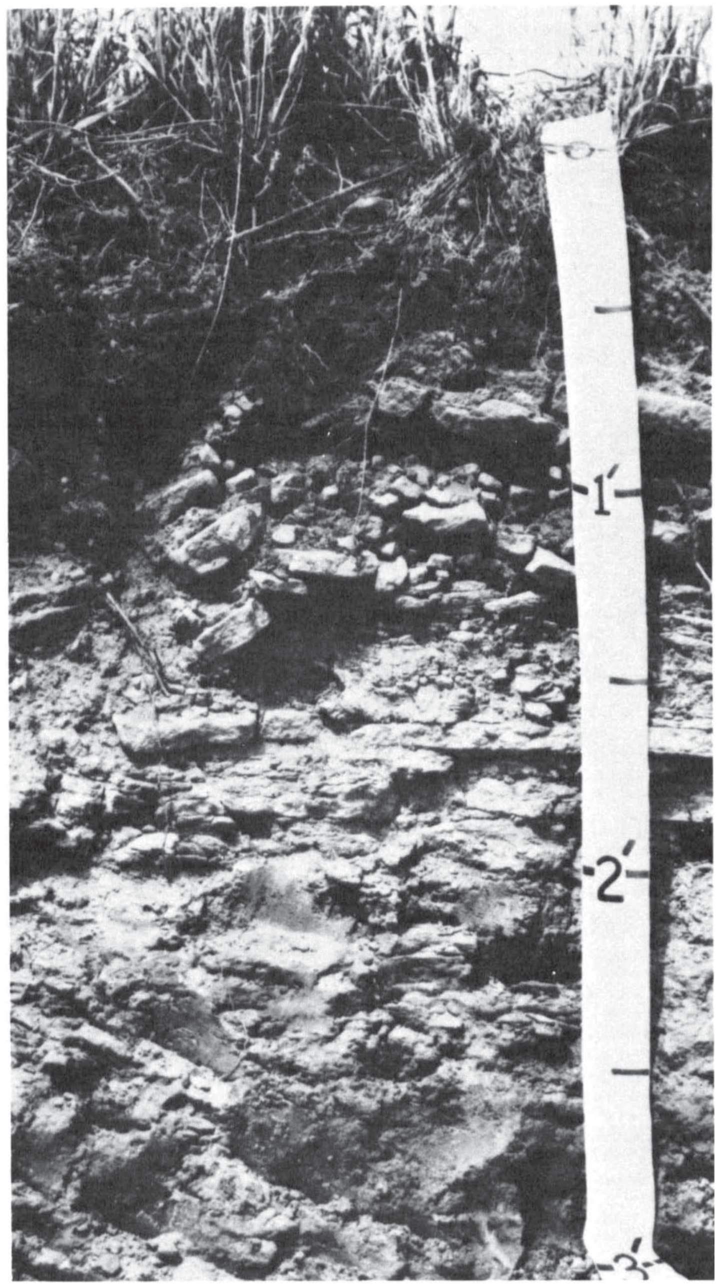


Figure 8.—Profile of a Coweta soil. Fractured sandstone is at a depth of 10 inches.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature[1]						Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[2]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	47.0	24.4	35.7	73	-1	0	1.17	.57	1.64	3	2.6
February---	52.8	28.5	40.6	78	4	15	1.67	.94	2.30	4	2.7
March------	60.9	35.4	48.1	88	11	125	3.10	1.22	4.61	5	2.4
April------	72.6	46.7	59.7	91	24	308	3.60	1.86	5.02	6	.3
May--------	80.4	56.0	68.2	94	35	564	4.41	2.44	6.00	7	.0
June-------	88.2	64.6	76.4	101	49	792	4.93	2.20	7.14	6	.0
July-------	94.3	69.4	81.8	107	54	986	3.25	.89	5.14	5	.0
August-----	94.0	67.3	80.7	107	54	952	3.39	1.56	4.87	4	.0
September--	85.6	59.8	72.7	100	40	681	4.74	1.75	7.17	5	.0
October----	75.0	48.5	61.8	93	29	374	3.66	.87	5.89	5	.0
November---	60.9	36.2	48.6	81	14	88	2.44	.46	3.99	4	1.1
December---	49.9	28.0	39.0	73	1	14	2.01	.93	2.88	4	2.7
Year-----	71.8	47.1	59.4	110	-3	4,899	38.37	29.15	46.98	58	11.8

[1]Recorded in the period 1951-74 at Nowata, Okla.

[2]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 5	April 16	April 25
2 years in 10 later than--	March 31	April 10	April 20
5 years in 10 later than--	March 20	March 29	April 11
First freezing temperature in fall:			
1 year in 10 earlier than--	October 28	October 24	October 16
2 years in 10 earlier than--	November 4	October 29	October 21
5 years in 10 earlier than--	November 17	November 7	October 30

[1]Recorded in the period 1951-74 at Nowata, Okla.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	213	196	180
8 years in 10	222	205	187
5 years in 10	241	222	202
2 years in 10	259	239	216
1 year in 10	269	248	223

[1]Recorded in the period 1951-74 at Nowata, Okla.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
AeB	Apperson silty clay loam, 1 to 3 percent slopes	19,300	5.2
CaB	Catoosa silt loam, 1 to 3 percent slopes	18,900	5.1
CbB	Coweta-Bates complex, 1 to 5 percent slopes	46,800	12.8
CeC	Coweta-Eram complex, 5 to 15 percent slopes	12,250	3.3
DnB	Dennis silt loam, 1 to 3 percent slopes	25,650	6.9
DnC	Dennis silt loam, 3 to 5 percent slopes	22,300	6.1
EHC	Enders-Hector association, sloping	8,870	2.4
ErD	Eram-Radley complex, 0 to 8 percent slopes	17,100	4.6
KaD	Kanima very shaly silt loam, 1 to 8 percent slopes	1,100	0.3
LHC	Liberal-Hector association, sloping	9,680	2.6
Ma	Mason silt loam	9,670	2.6
NoB	Nowata silt loam, 2 to 5 percent slopes	6,300	1.7
Ow	Oil-waste land	300	0.1
OkA	Okemah silt loam, 0 to 1 percent slopes	19,700	5.3
Os	Osage clay	5,550	1.5
PaA	Parsons silt loam, 0 to 1 percent slopes	12,650	3.4
PaB	Parsons silt loam, 1 to 3 percent slopes	23,700	6.4
Pt	Pits	300	0.1
Ra	Radley silt loam	2,200	0.6
RD	Radley soils	17,100	4.6
ReB	Riverton loam, 1 to 3 percent slopes	750	0.2
ScB	Shidler-Claremore complex, 1 to 3 percent slopes	35,850	9.8
SkD	Shidler-Kiti-Limestone outcrop complex, 1 to 8 percent slopes	19,950	5.4
SuC	Summit silty clay loam, 3 to 5 percent slopes	10,730	2.9
Wa	Wynona silty clay loam	13,000	3.5
	Water	9,580	2.6
	Total	369,280	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Wheat	Grain sorghum	Soybeans	Alfalfa hay	Tall fescue	Improved bermudagrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
AeB: Apperson	35	65	30	3.5	7.0	7.0
CaB: Catoosa	35	55	25	---	5.0	6.5
CbB: Coweta-Bates	---	---	---	---	3.5	4.2
CeC: Coweta-Eram	---	---	---	---	4.0	4.0
DnB: Dennis	40	70	35	3.5	6.0	7.0
DnC: Dennis	35	65	30	3.0	5.5	6.5
EHC**:						
Enders	---	---	---	---	3.0	4.0
Hector	---	---	---	---	3.0	4.0
ErD: Eram-Radley	---	---	---	---	4.5	6.0
KaD: Kanima	---	---	---	---	---	---
LHC**:						
Liberal	---	---	---	---	3.5	4.5
Hector	---	---	---	---	3.5	4.5
Ma: Mason	40	75	35	4.5	8.0	8.0
NoB: Nowata	25	35	20	---	4.0	4.0
Ow** Oil-waste land						
OkA: Okemah	40	70	35	4.0	6.5	7.0
Os: Osage	30	65	30	4.0	6.5	6.0
PaA: Parsons	35	55	30	---	6.0	6.0
PaB: Parsons	30	50	25	---	4.5	5.5
Pt** Pits						
Ra: Radley	40	70	30	4.5	7.0	8.0
RD: Radley	---	---	---	---	6.5	6.5

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Wheat	Grain sorghum	Soybeans	Alfalfa hay	Tall fescue	Improved bermudagrass
	Bu	Bu	Bu	Ton	AUM*	AUM*
ReB----------------------- Riverton	30	50	20	---	5.0	6.0
ScB----------------------- Shidler-Claremore	---	---	---	---	3.0	4.0
SkD----------------------- Shidler-Kiti-Limestone outcrop	---	---	---	---	---	---
SuC----------------------- Summit	30	60	30	3.0	6.5	6.5
Wa------------------------ Wynona	35	70	35	4.5	8.0	8.0

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
AeB: Apperson	Loamy Prairie	Favorable	6,000	Big bluestem	35
		Normal	4,300	Switchgrass	15
		Unfavorable	3,200	Little bluestem	10
				Indiangrass	10
				Scribner panicum	5
CaB: Catoosa	Loamy Prairie	Favorable	6,500	Little bluestem	25
		Normal	5,000	Big bluestem	20
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Sideoats grama	5
				Tall dropseed	5
				Lespedeza	5
				Dotted gayfeather	5
CbB*:					
Coweta	Shallow Prairie	Favorable	3,500	Little bluestem	30
		Normal	2,300	Big bluestem	15
		Unfavorable	1,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	10
				Scribner panicum	5
				Sideoats grama	5
				Prairie-clover	5
				Dotted gayfeather	5
Bates	Loamy Prairie	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	12
				Switchgrass	5
				Leadplant	5
CeC*:					
Coweta	Shallow Prairie	Favorable	3,500	Little bluestem	30
		Normal	2,300	Big bluestem	15
		Unfavorable	1,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	10
				Scribner panicum	5
				Sideoats grama	5
				Prairie-clover	5
				Dotted gayfeather	5
Eram	Loamy Prairie	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Scribner panicum	5
				Purpletop	5
				Tall dropseed	5
				Catclaw sensitivebrier	5
				Goldenrod	5
DnB, DnC: Dennis	Loamy Prairie	Favorable	7,000	Big bluestem	35
		Normal	5,500	Switchgrass	15
		Unfavorable	4,500	Little bluestem	10
				Indiangrass	10
				Scribner panicum	5
				Purpletop	5
				Tall dropseed	5
				Catclaw sensitivebrier	5
				Goldenrod	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
EHC*:					
Enders	Sandy Savannah	Favorable	5,000	Little bluestem	30
		Normal	3,400	Indiangrass	10
		Unfavorable	2,500	Canada wildrye	10
				Post oak	10
				Big bluestem	8
				Panicum	5
Hector	Shallow Savannah	Favorable	3,200	Little bluestem	45
		Normal	2,100	Indiangrass	10
		Unfavorable	1,400	Post oak	10
				Big bluestem	8
				Scribner panicum	5
ErD*:					
Eram	Loamy Prairie	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Scribner panicum	5
				Purpletop	5
				Tall dropseed	5
				Catclaw sensitivebrier	5
				Goldenrod	5
Radley.					
LHC*:					
Liberal	Loamy Prairie	Favorable	6,000	Big bluestem	25
		Normal	4,200	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
Hector	Shallow Savannah	Favorable	3,200	Little bluestem	45
		Normal	2,100	Indiangrass	15
		Unfavorable	1,400	Post oak	10
				Big bluestem	8
				Scribner panicum	5
NoB Nowata	Loamy Prairie	Favorable	5,000	Little bluestem	25
		Normal	3,300	Big bluestem	20
		Unfavorable	2,200	Indiangrass	10
				Switchgrass	10
				Scribner panicum	5
OkA Okemah	Loamy Prairie	Favorable	7,000	Big bluestem	35
		Normal	5,500	Switchgrass	15
		Unfavorable	4,500	Little bluestem	10
				Indiangrass	10
				Scribner panicum	5
				Purpletop	5
				Tall dropseed	5
				Catclaw sensitivebrier	5
				Goldenrod	5
PaA, PaB Parsons	Claypan Prairie	Favorable	4,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Sideoats grama	5
				Goldenrod	5
				Indiancurrant coralberry	5
ReB Riverton	Loamy Savannah	Favorable	3,500	Little bluestem	15
		Normal	2,300	Scribner panicum	10
		Unfavorable	1,500	Big bluestem	5
				Indiangrass	5
				Switchgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
ScB*:					
Shidler	Very Shallow	Favorable	2,500	Sideoats grama	30
		Normal	1,300	Little bluestem	25
		Unfavorable	500	Big bluestem	5
				Hairy grama	5
				Purple prairie-clover	5
				Threeawn	5
Claremore	Loamy Prairie	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	10
				Scribner panicum	5
				Purpletop	5
				Tall dropseed	5
				Catclaw sensitivebrier	5
				Goldenrod	5
SkD*:					
Shidler	Very Shallow	Favorable	2,200	Sideoats grama	25
		Normal	1,200	Little bluestem	20
		Unfavorable	500	Big bluestem	5
				Hairy grama	5
				Purple prairie-clover	5
				Tridens	5
				Threeawn	5
Kiti	Edge Rock	Favorable	2,800	Little bluestem	20
		Normal	2,000	Sideoats grama	20
		Unfavorable	1,400	Big bluestem	10
				Indiangrass	10
				Tridens	10
				Hairy grama	5
Limestone outcrop.					
SuC Summit	Loamy Prairie	Favorable	7,000	Big bluestem	35
		Normal	5,500	Switchgrass	15
		Unfavorable	4,500	Little bluestem	10
				Indiangrass	10
				Scribner panicum	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
EHC*:							
Enders	5o	Slight	Slight	Slight	Post oak	50	
Hector	5d	Slight	Slight	Moderate	Eastern redcedar	30	
ErD*: Eram.							
Radley	3o	Slight	Slight	Slight	Black walnut Northern red oak Pin oak Common hackberry Green ash	79 69 82 68 73	Black walnut, pecan, American sycamore, common hackberry, green ash.
LHC*: Liberal.							
Hector	5d	Slight	Slight	Moderate	Eastern redcedar	30	
Ma Mason	3o	Slight	Slight	Slight	Eastern cottonwood Northern red oak Green ash Black walnut	90 --- --- ---	Sweetgum, bur oak, green ash, black walnut, pecan, American sycamore.
Os Osage	4w	Slight	Moderate	Moderate	Bur oak Pecan Eastern cottonwood	75 50 65	Bur oak, pecan.
Ra, RD* Radley	3o	Slight	Slight	Slight	Black walnut Northern red oak Pin oak Common hackberry Green ash	79 69 82 68 73	Black walnut, pecan, American sycamore, common hackberry, green ash.
ReB Riverton	5f	Slight	Slight	Moderate	Eastern redcedar	35	
Wa Wynona	3w	Slight	Moderate	Moderate	Pin oak Pecan Eastern cottonwood Green ash Black walnut	--- --- 90 76 ---	Green ash, bur oak, pecan, eastern cottonwood, American sycamore.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND UNDERSTORY VEGETATION

[Only the soils suitable for production of commercial trees are listed]

Soil name and map symbol	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
		Lb/acre		Pct
EHC*:				
Enders	Favorable	3,000	Little bluestem	30
	Normal	2,200	Indiangrass	10
	Unfavorable	1,500	Canada wildrye	10
			Post oak	10
			Big bluestem	8
			Panicum	5
Hector	Favorable	2,500	Little bluestem	45
	Normal	2,000	Indiangrass	15
	Unfavorable	1,200	Post oak	10
			Big bluestem	8
			Scribner panicum	5
ErD*:				
Eram.				
Radley	Favorable	4,500	Big bluestem	40
	Normal	3,000	Indiangrass	20
	Unfavorable	2,000	Switchgrass	10
			Eastern gamagrass	8
			Little bluestem	5
LHC*:				
Liberal.				
Hector	Favorable	2,500	Little bluestem	45
	Normal	2,000	Indiangrass	15
	Unfavorable	1,200	Post oak	10
			Big bluestem	8
			Scribner panicum	5
Ma	Favorable	4,500	Big bluestem	25
Mason	Normal	3,000	Indiangrass	20
	Unfavorable	2,000	Switchgrass	15
			Little bluestem	10
			Eastern gamagrass	5
			Sedge	5
			Compassplant	5
Os	Favorable	5,500	Switchgrass	30
Osage	Normal	4,500	Indiangrass	15
	Unfavorable	3,500	Big bluestem	15
			Eastern gamagrass	10
			Little bluestem	10
			Prairie cordgrass	10
			Sunflower	5
			Eastern cottonwood	5
Ra, RD*	Favorable	4,500	Big bluestem	40
Radley	Normal	3,000	Indiangrass	20
	Unfavorable	2,000	Switchgrass	10
			Eastern gamagrass	8
			Little bluestem	5
ReB	Favorable	5,000	Big bluestem	15
Riverton	Normal	3,500	Little bluestem	15
	Unfavorable	2,500	Switchgrass	10
			Indiangrass	5
			Scribner panicum	5

See footnote at end of table.

TABLE 8.--WOODLAND UNDERSTORY VEGETATION--Continued

Soil name and map symbol	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
		Lb/acre		Pct
Wa: Wynona	Favorable	4,500	Little bluestem	15
	Normal	3,000	Big bluestem	10
	Unfavorable	2,000	Indiangrass	5
			Switchgrass	5
			Sedge	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
AeB------------- Apperson	Severe: too clayey, depth to rock, wetness.	Severe: shrink-swell, low strength, wetness.	Severe: low strength, shrink-swell, wetness.	Severe: low strength, shrink-swell, wetness.	Severe: low strength, shrink-swell.
CaB------------- Catoosa	Severe: depth to rock.	Moderate: low strength, depth to rock, shrink-swell.	Severe: depth to rock.	Moderate: low strength, depth to rock, shrink-swell.	Severe: low strength.
CbB*:					
Coweta----------	Moderate: slope, depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.
Bates-----------	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
CeC*:					
Coweta----------	Moderate: slope, depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: depth to rock, slope.
Eram------------	Severe: too clayey, wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, wetness.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
DnB, DnC-------- Dennis	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
EHC*:					
Enders----------	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: slope, low strength, shrink-swell.	Severe: low strength, shrink-swell.
Hector----------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
ErD*:					
Eram------------	Severe: too clayey, wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, wetness.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Radley----------	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
KaD------------- Kanima	Moderate: too clayey.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
LHC*:					
Liberal---------	Severe: wetness, too clayey.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
LHC*:					
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Ma: Mason	Moderate: too clayey, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, shrink-swell.
NoB: Nowata	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, low strength.	Severe: depth to rock.	Moderate: depth to rock, shrink-swell, low strength.	Severe: low strength.
Ow*. Oil-waste land					
OkA: Okemah	Severe: too clayey, wetness.	Severe: low strength, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Os: Osage	Severe: wetness, floods, too clayey.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.
PaA, PaB: Parsons	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.
Pt*. Pits					
Ra, RD*: Radley	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
ReB: Riverton	Moderate: too clayey, small stones.	Slight	Slight	Slight	Slight.
ScB*:					
Shidler	Severe: depth to rock, large stones.	Severe: depth to rock, low strength, large stones.	Severe: depth to rock, low strength, large stones.	Severe: depth to rock, low strength, large stones.	Severe: depth to rock, low strength, large stones.
Claremore	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
SkD*:					
Shidler	Severe: depth to rock, large stones.	Severe: depth to rock, large stones, low strength.	Severe: depth to rock, large stones, low strength.	Severe: depth to rock, large stones, low strength.	Severe: depth to rock, large stones, low strength.
Kiti	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Limestone outcrop.					
SuC: Summit	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Wa----------------- Wynona	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: floods, low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and "fair." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
AeB------------------ Apperson	Severe: percs slowly, depth to rock, wetness.	Moderate: depth to rock, wetness.	Severe: too clayey, depth to rock, wetness.	Severe: wetness.	Poor: too clayey.
CaB------------------ Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Fair: thin layer.
CbB*:					
Coweta--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Poor: thin layer.
Bates---------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Fair: thin layer.
CeC*:					
Coweta--------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Moderate: slope.	Poor: thin layer.
Eram----------------	Severe: percs slowly, wetness, depth to rock.	Severe: depth to rock.	Severe: too clayey.	Severe: wetness.	Poor: thin layer.
DnB, DnC------------ Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Severe: wetness.	Poor: thin layer.
EHC*:					
Enders--------------	Severe: percs slowly.	Severe: slope.	Severe: depth to rock, too clayey.	Moderate: slope.	Poor: too clayey.
Hector--------------	Severe: depth to rock.	Severe: slope, depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: thin layer.
ErD*:					
Eram----------------	Severe: percs slowly, wetness, depth to rock.	Severe: depth to rock.	Severe: too clayey.	Severe: wetness.	Poor: thin layer.
Radley--------------	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
KaD------------------ Kanima	Slight------------	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
LHC*:					
Liberal-------------	Severe: percs slowly, wetness.	Moderate: depth to rock.	Severe: too clayey, wetness.	Moderate: slope.	Poor: too clayey.
Hector--------------	Severe: depth to rock.	Severe: slope, depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: thin layer.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ma Mason	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Fair: thin layer.
NoB Nowata	Severe: percs slowly, depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: small stones.
Ow*. Oil-waste land					
OkA Okemah	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Fair: thin layer.
Os Osage	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
PaA Parsons	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Poor: too clayey.
PaB Parsons	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Severe: wetness.	Poor: too clayey.
Pt*. Pits					
Ra, RD* Radley	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
ReB Riverton	Slight	Moderate: seepage, small stones.	Moderate: too clayey.	Slight	Poor: small stones.
ScB*: Shidler	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Slight	Poor: thin layer, large stones.
Claremore	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: thin layer, area reclaim.
SkD*: Shidler	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, large stones.	Slight	Poor: thin layer, large stones.
Kiti	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Slight	Poor: thin layer.
Limestone outcrop.					
SuC Summit	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
Wa Wynona	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
AeB------------------- Apperson	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
CaB------------------- Catoosa	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
CbB*:				
Coweta---------------	Fair: low strength, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Bates----------------	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
CeC*:				
Coweta---------------	Fair: low strength, slope.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Eram-----------------	Poor: low strength, shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
DnB, DnC-------------- Dennis	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
EHC*:				
Enders---------------	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, small stones.
Hector---------------	Poor: thin layer.	Poor: excess fines.	Poor: excess fines.	Poor: thin layer, small stones, area reclaim.
ErD*:				
Eram-----------------	Poor: low strength, shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Radley---------------	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
KaD------------------- Kanima	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones.
LHC*:				
Liberal--------------	Poor: shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Hector---------------	Poor: thin layer.	Poor: excess fines.	Poor: excess fines.	Poor: thin layer, small stones, area reclaim.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ma--------------------- Mason	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
NoB-------------------- Nowata	Poor: low strength.	Unsuited: excess fines.	Poor: excess fines.	Fair: small stones.
Ow*. Oil-waste land				
OkA-------------------- Okemah	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Os--------------------- Osage	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
PaA, PaB--------------- Parsons	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Pt*. Pits				
Ra, RD*---------------- Radley	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
ReB-------------------- Riverton	Good	Unsuited: excess fines.	Poor: excess fines.	Poor: thin layer, small stones.
ScB*: Shidler---------------	Poor: thin layer, low strength, large stones.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, large stones.
Claremore-------------	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim.
SkD*: Shidler---------------	Poor: thin layer, low strength, large stones.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, large stones.
Kiti------------------	Poor: thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Limestone outcrop.				
SuC-------------------- Summit	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Wa--------------------- Wynona	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
AeB: Apperson	Moderate: depth to rock.	Moderate: unstable fill, thin layer, compressible.	Severe: slow refill.	Wetness, percs slowly.	Percs slowly, wetness.	Percs slowly, wetness.
CaB: Catoosa	Severe: depth to rock.	Moderate: unstable fill, piping, thin layer.	Severe: no water.	Not needed	Depth to rock, rooting depth, droughty.	Rooting depth, droughty.
CbB*:						
Coweta	Severe: depth to rock.	Severe: thin layer.	Severe: no water.	Not needed	Depth to rock, rooting depth, slope.	Droughty, rooting depth, slope.
Bates	Severe: depth to rock, erodes easily.	Moderate: thin layer.	Severe: no water.	Not needed	Slope, depth to rock, erodes easily.	Slope, erodes easily, rooting depth.
CeC*:						
Coweta	Severe: depth to rock.	Severe: thin layer.	Severe: no water.	Not needed	Depth to rock, rooting depth, slope.	Droughty, rooting depth, slope.
Eram	Slight	Moderate: unstable fill, thin layer.	Severe: no water.	Percs slowly	Percs slowly	Percs slowly.
DnB, DnC: Dennis	Slight	Moderate: unstable fill, compressible, piping.	Severe: no water.	Percs slowly	Percs slowly	Percs slowly.
EHC*:						
Enders	Moderate: depth to rock.	Severe: low strength, compressible.	Severe: deep to water, large stones.	Not needed	Slope, depth to rock, erodes easily.	Erodes easily, percs slowly, slope.
Hector	Severe: depth to rock, seepage.	Severe: thin layer.	Severe: no water.	Not needed	Slope, depth to rock, rooting depth.	Droughty, rooting depth, slope.
ErD*:						
Eram	Slight	Moderate: unstable fill, thin layer.	Severe: no water.	Percs slowly	Percs slowly	Percs slowly.
Radley	Moderate: seepage.	Moderate: low strength, piping.	Severe: deep to water.	Floods	Floods	Favorable.
KaD: Kanima	Moderate: seepage.	Moderate: seepage, low strength.	Severe: deep to water.	Not needed	Not needed	Not needed.
LHC*:						
Liberal	Moderate: slope.	Moderate: compressible, low strength, shrink-swell.	Severe: slow refill.	Not needed	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly, slope.
Hector	Severe: depth to rock, seepage.	Severe: thin layer.	Severe: no water.	Not needed	Slope, depth to rock, rooting depth.	Droughty, rooting depth, slope.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
Ma---------------- Mason	Moderate: seepage.	Moderate: unstable fill, piping, compressible.	Severe: no water.	Not needed-----	Not needed-----	Not needed.
NoB--------------- Nowata	Severe: depth to rock.	Moderate: thin layer, low strength.	Severe: depth to rock, no water.	Not needed-----	Rooting depth	Droughty.
Ow*. Oil-waste land						
OkA--------------- Okemah	Slight---------	Moderate: unstable fill.	Severe: no water.	Percs slowly---	Percs slowly---	Percs slowly.
Os---------------- Osage	Slight---------	Moderate: shrink-swell, low strength, compressible.	Severe: slow refill.	Floods, percs slowly, wetness.	Percs slowly, wetness.	Percs slowly, wetness.
PaA, PaB---------- Parsons	Slight---------	Moderate: unstable fill, compressible.	Severe: no water.	Percs slowly, wetness.	Percs slowly, wetness.	Percs slowly, wetness.
Pt* Pits						
Ra---------------- Radley	Moderate: seepage.	Moderate: low strength, piping.	Severe: deep to water.	Floods---------	Floods---------	Favorable.
RD*--------------- Radley	Moderate: seepage.	Moderate: low strength, piping.	Severe: deep to water.	Floods---------	Floods---------	Favorable.
ReB--------------- Riverton	Severe: depth to rock.	Moderate: unstable fill, piping.	Severe: deep to water.	Not needed-----	Erodes easily	Droughty.
ScB*: Shidler----------	Severe: depth to rock.	Severe: depth to rock.	Severe: no water.	Not needed-----	Depth to rock, large stones.	Rooting depth, large stones.
Claremore--------	Severe: depth to rock.	Severe: thin layer.	Severe: no water.	Not needed-----	Depth to rock	Rooting depth.
SkD*: Shidler----------	Severe: depth to rock.	Severe: depth to rock.	Severe: no water.	Not needed-----	Depth to rock, large stones.	Rooting depth, large stones.
Kiti-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: deep to water.	Not needed-----	Not needed-----	Not needed.
Limestone outcrop.						
SuC--------------- Summit	Slight---------	Severe: compressible, piping.	Severe: slow refill.	Percs slowly---	Percs slowly, wetness.	Percs slowly, wetness.
Wa---------------- Wynona	Slight---------	Moderate: compressible, unstable fill.	Severe: slow refill.	Floods, percs slowly.	Not needed-----	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
AeB Apperson	Moderate: too clayey, wetness, percs slowly.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness, percs slowly.	Moderate: too clayey.
CaB Catoosa	Slight	Slight	Moderate: depth to rock, slope.	Slight.
CbB*:				
Coweta	Slight	Slight	Severe: depth to rock, slope, large stones.	Slight.
Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.
CeC*:				
Coweta	Moderate: slope.	Moderate: slope.	Severe: depth to rock, slope, large stones.	Slight.
Eram	Moderate: percs slowly, wetness.	Slight	Severe: slope.	Slight.
DnB, DnC Dennis	Moderate: wetness, percs slowly.	Slight	Moderate: percs slowly, slope, wetness.	Slight.
EHC*:				
Enders	Severe: percs slowly.	Moderate: slope.	Severe: slope, percs slowly.	Slight.
Hector	Moderate: slope.	Moderate: slope.	Severe: slope, depth to rock.	Slight.
ErD*:				
Eram	Moderate: percs slowly, wetness.	Slight	Moderate: slope, percs slowly, wetness.	Slight.
Radley	Severe: floods.	Moderate: floods.	Severe: floods.	Slight.
KaD Kanima	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey, slope.	Moderate: too clayey.
LHC*:				
Liberal	Moderate: percs slowly, wetness.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 13.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
LHC*:				
Hector	Moderate: slope.	Moderate: slope.	Severe: slope, depth to rock.	Slight.
Ma Mason	Severe: floods.	Moderate: floods.	Moderate: percs slowly, floods.	Slight.
NoB Nowata	Moderate: percs slowly.	Slight	Moderate: percs slowly, depth to rock.	Slight.
Ow*. Oil-waste land				
OkA Okemah	Moderate: percs slowly, wetness.	Slight	Moderate: percs slowly, wetness.	Slight.
Os Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, floods, too clayey.	Severe: wetness, floods, percs slowly.	Severe: wetness, too clayey.
PaA, PaB Parsons	Severe: percs slowly.	Moderate: wetness.	Severe: percs slowly.	Moderate: wetness.
Pt*. Pits				
Ra Radley	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
RD* Radley	Severe: floods.	Moderate: floods.	Severe: floods.	Slight.
ReB Riverton	Slight	Slight	Slight	Slight.
ScB*:				
Shidler	Severe: large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: large stones.
Claremore	Slight	Slight	Severe: depth to rock.	Slight.
SkD*:				
Shidler	Severe: large stones.	Moderate: large stones.	Severe: depth to rock, large stones.	Severe: large stones.
Kiti	Moderate: small stones.	Moderate: small stones.	Severe: depth to rock.	Moderate: small stones.
Limestone outcrop.				
SuC Summit	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
Wa Wynona	Severe: floods, wetness.	Moderate: wetness, floods, too clayey.	Severe: floods, wetness.	Moderate: too clayey, wetness, floods.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
AeB: Apperson	Good	Good	Fair	Good	Good	---	Poor	Poor	Good	Good	Poor.
CaB: Catoosa	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
CbB*:											
Coweta	Very poor.	Poor	Poor	Very poor.	Very poor.	---	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Bates	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
CeC*:											
Coweta	Very poor.	Poor	Poor	Very poor.	Very poor.	---	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Eram	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
DnB: Dennis	Good	Good	Good	Good	Good	---	Poor	Poor	Good	Good	Poor.
DnC: Dennis	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
EHC*:											
Enders	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.
Hector	Very poor.	Poor	Poor	Poor	Very poor.	---	Very poor.	Very poor.	Poor	Poor	Very poor.
ErD*:											
Eram	Fair	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
Radley	Poor	Fair	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
KaD: Kanima	Poor	Fair	Fair	Poor	Poor	---	Very poor.	Very poor.	Fair	Poor	Very poor.
LHC*:											
Liberal	Fair	Good	Good	Good	Good	---	Very poor.	Very poor.	Good	Good	Very poor.
Hector	Very poor.	Poor	Poor	Poor	Very poor.	---	Very poor.	Very poor.	Poor	Poor	Very poor.
Ma: Mason	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
NoB: Nowata	Fair	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
Ow*. Oil-waste land											
OkA: Okemah	Good	Good	Good	Good	Good	---	Poor	Poor	Good	Good	Poor.
Os: Osage	Fair	Fair	Fair	Fair	Fair	---	Poor	Good	Fair	Fair	Fair.

See footnote at end of table.

TABLE 14.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
PaA----------------- Parsons	Fair	Good	Good	Good	Good	---	Fair	Fair	Good	Good	Fair.
PaB----------------- Parsons	Fair	Good	Good	Good	Good	---	Fair	Poor	Good	Good	Poor.
Pt*. Pits											
Ra------------------ Radley	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
RD*----------------- Radley	Poor	Fair	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair.
ReB----------------- Riverton	Good	Good	Good	Good	Good	---	Poor	Very poor.	Good	Good	Very poor.
ScB*:											
Shidler------------	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.
Claremore----------	Poor	Poor	Fair	Fair	Fair	---	Poor	Very poor.	Poor	Fair	Very poor.
SkD*:											
Shidler------------	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.
Kiti---------------	Very poor.	Poor	Poor	---	---	Very poor.	Very poor.	Very poor.	Poor	---	Very poor.
Limestone outcrop.											
SuC----------------- Summit	Fair	Good	Fair	Good	Good	---	Poor	Very poor.	Fair	Good	Very poor.
Wa------------------ Wynona	Good	Good	Good	Good	Good	---	Fair	Fair	Good	Good	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
AeB----------------- Apperson	0-10	Silty clay loam	CL, ML	A-6, A-7	0	100	100	95-100	75-98	33-44	12-20
	10-15	Silty clay loam, silty clay.	CL, CH, MH	A-7	0	100	100	95-100	80-99	41-70	20-40
	15-44	Silty clay------	CL, CH, MH	A-7	0	85-100	83-100	80-100	75-99	41-70	20-40
	44-46	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
CaB----------------- Catoosa	0-12	Silt loam-------	ML, CL	A-4, A-6	0	100	100	96-100	65-97	30-37	9-13
	12-18	Silt loam, loam, clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	9-20
	18-35	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	35-37	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
CbB*:											
Coweta------------	0-10	Loam------------	ML, CL	A-4	0	90-100	90-100	80-90	60-85	<31	NP-10
	10-16	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	0-25	55-75	55-75	45-70	30-65	<31	NP-12
	16-24	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Bates-------------	0-18	Loam------------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	55-90	20-40	3-15
	18-34	Loam, clay loam, sandy clay loam.	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	50-85	25-40	3-15
	34-36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
CeC*:											
Coweta------------	0-9	Fine sandy loam	ML, CL, SM, SC	A-4	0-15	70-100	70-100	60-90	36-85	<31	NP-10
	9-14	Fine sandy loam, loam, clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	0-25	55-75	55-75	45-70	30-65	<31	NP-12
	14-25	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Eram--------------	0-11	Silt loam-------	ML, CL	A-6, A-4	0	98-100	98-100	85-100	75-95	30-40	8-18
	11-26	Clay, silty clay, clay loam.	ML, CL, CH, MH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	26-50	Weathered bedrock.	---	---	---	---	---	---	---	---	---
DnB, DnC----------- Dennis	0-13	Silt loam-------	ML, CL-ML	A-4	0	100	100	96-100	65-97	20-30	1-7
	13-17	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	17-78	Clay, silty clay, silty clay loam.	CL, CH, ML, MH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
EHC*:											
Enders------------	0-5	Loam------------	ML, CL, SM, SC	A-4	0	80-100	80-97	75-90	40-85	25-35	4-10
	5-8	Clay loam, silty clay loam, loam.	CL, ML	A-6	0	80-100	80-100	80-100	75-95	30-40	11-15
	8-46	Silty clay, clay	MH, CH	A-7	0	95-100	85-100	85-100	70-95	65-80	35-45
	46-62	Weathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
EHC*:											
Hector	0-6	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4, A-2	0	80-100	80-100	80-100	30-65	<30	NP-6
	6-15	Fine sandy loam, gravelly fine sandy loam, gravelly loam.	SM, ML, GM, GM-GC	A-4, A-2	0-15	55-100	55-100	45-100	30-65	<30	NP-6
	15-16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
ErD*:											
Eram	0-8	Silt loam	ML, CL	A-6, A-4	0	98-100	98-100	85-100	75-95	30-40	8-16
	8-28	Clay, silty clay, clay loam.	ML, CL, CH, MH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	28-34	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Radley	0-18	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	80-100	30-37	8-13
	18-60	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	94-100	85-100	30-40	8-16
KaD Kanima	0-4	Shaly silt loam	ML, CL, SM, SC	A-2, A-4, A-6	0-7	10-80	5-75	5-70	5-70	15-35	1-14
	4-70	Very shaly clay loam, very shaly silt loam, very shaly silty clay loam.	ML, CL, SM, SC	A-2, A-4, A-6	7-40	10-60	5-55	5-55	5-55	15-35	1-14
LHC*:											
Liberal	0-7	Silty clay loam	CL	A-4, A-6	0	100	100	90-100	75-95	25-35	10-15
	7-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	30-45	15-25
	12-28	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	95-100	90-95	40-60	25-40
	28-45	Silty clay, clay	CH	A-7	0	100	100	90-100	75-95	50-65	30-40
	45-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Hector	0-6	Loam	SM, ML, SM-SC, CL-ML	A-4, A-2	0	80-100	80-100	80-100	30-65	<30	NP-6
	6-14	Fine sandy loam, gravelly fine sandy loam, gravelly loam.	SM, ML, GM, GM-GC	A-4, A-2	0-15	55-100	55-100	45-100	30-65	<30	NP-6
	14-16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ma Mason	0-18	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	80-98	30-35	8-13
	18-64	Silty clay loam, clay loam, silt loam.	CL, ML	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
NoB: Nowata	0-12	Silt loam	CL	A-4, A-6	0-15	85-100	80-100	75-95	70-95	30-37	8-13
	12-18	Silt loam, silty clay loam, gravelly silt loam.	CL, GC, SC	A-2, A-4, A-6	0-30	40-90	35-90	35-85	30-85	30-40	8-18
	18-36	Gravelly silty clay loam, very gravelly silty clay loam, cherty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	33-42	12-19
	36-38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ow*. Oil-waste land											
OkA: Okemah	0-18	Silt loam	CL, ML	A-4, A-6, A-7	0	98-100	98-100	96-100	80-98	30-42	8-19
	18-56	Silty clay, clay, silty clay loam.	CL, CH, MH, ML	A-7	0	98-100	98-100	96-100	80-99	45-70	19-44
	56-72	Silty clay, clay, silty clay loam.	CL, CH, MH, ML	A-7	0	98-100	98-100	96-100	90-99	48-65	21-38
Os: Osage	0-18	Clay	CH	A-7	0	100	100	100	95-100	50-75	30-55
	18-76	Silty clay, clay	CH	A-7	0	100	100	100	95-100	50-80	30-55
PaA, PaB: Parsons	0-15	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	96-100	96-100	80-97	20-37	1-12
	15-74	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	96-100	96-100	80-99	37-70	15-40
Pt*. Pits											
Ra, RD*: Radley	0-18	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	80-100	30-37	8-13
	18-64	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	94-100	85-100	30-40	8-16
ReB: Riverton	0-9	Loam	CL, ML, CL-ML	A-4	0	80-90	75-85	60-75	50-60	22-31	3-10
	9-15	Gravelly loam, gravelly clay loam.	GC, SC	A-2, A-6	0	60-80	55-75	40-60	30-50	33-40	11-18
	15-55	Gravelly clay loam, very gravelly clay loam, very gravelly silty clay loam.	GC	A-2	0	5-50	5-50	5-40	5-35	33-40	11-18
	55-80	Very gravelly clay loam, very gravelly clay.	GC	A-2	0	5-50	5-50	5-40	5-35	37-60	16-33
ScB*: Shidler	0-13	Silt loam	CL, ML, SC, SM	A-4, A-6	0-45	55-90	55-90	50-90	45-90	30-37	8-13
	13-15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
ScB*:											
Claremore	0-8	Silt loam	ML, CL	A-4, A-6	0	98-100	95-100	90-100	65-85	20-35	2-14
	8-12	Silty clay loam, silt loam.	CL	A-4, A-6	0	98-100	95-100	90-100	80-95	26-39	8-18
	12-18	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	95-100	90-100	80-95	33-43	13-20
	18-20	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
SkD*:											
Shidler	0-15	Silt loam	CL, ML, SC, SM	A-4, A-6	0-45	55-90	55-90	50-90	45-90	30-37	8-13
	15-17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Kiti	0-13	Silty clay loam	CL, ML	A-4, A-6	45-75	85-95	80-90	75-85	65-85	30-40	8-17
	13-15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Limestone outcrop.											
SuC Summit	0-11	Silty clay loam	CL, CH, ML, MH	A-6, A-7	0	100	100	96-100	80-99	35-60	11-30
	11-18	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7, A-6	0	100	100	96-100	80-99	37-65	15-35
	18-80	Clay, silty clay	CH, MH, CL	A-7	0	98-100	98-100	96-100	80-98	41-70	18-40
Wa Wynona	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	98-100	90-98	33-42	12-19
	20-65	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	98-100	90-99	33-55	12-30

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permea-bility	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T
	In	In/hr	In/in	pH					
AeB: Apperson	0-10	0.2-0.6	0.16-0.20	5.6-6.5	Moderate	High	Low	0.37	3
	10-15	0.2-0.6	0.16-0.20	5.6-7.8	High	High	Low	0.37	
	15-44	0.06-0.2	0.14-0.18	6.1-8.4	High	High	Low	0.32	
	44-46	---	---	---	---	---	---	---	
CaB: Catoosa	0-12	0.6-2.0	0.15-0.24	5.6-6.5	Low	Low	Moderate	0.37	2
	12-18	0.6-2.0	0.15-0.24	5.6-6.5	Moderate	Moderate	Moderate	0.37	
	18-35	0.6-2.0	0.15-0.22	5.1-7.3	Moderate	Moderate	Moderate	0.32	
	35-37	---	---	---	---	---	---	---	
CbB*:									
Coweta	0-10	2.0-6.0	0.09-0.16	5.1-6.5	Low	Low	Moderate	0.32	2
	10-16	0.6-2.0	0.09-0.18	5.1-6.5	Low	Low	Moderate	0.24	
	16-24	---	---	---	---	---	---	---	
Bates	0-18	0.6-2.0	0.20-0.22	5.1-6.5	Low	Low	Moderate	0.28	4
	18-34	0.6-2.0	0.15-0.19	5.1-6.5	Moderate	Low	Moderate	0.28	
	34-36	---	---	---	---	---	---	---	
CeC*:									
Coweta	0-9	2.0-6.0	0.09-0.16	5.1-6.5	Low	Low	Moderate	0.32	2
	9-14	0.6-2.0	0.09-0.18	5.1-6.5	Low	Low	Moderate	0.24	
	14-25	---	---	---	---	---	---	---	
Eram	0-11	0.2-0.6	0.15-0.19	5.6-6.5	Moderate	High	Moderate	0.43	3
	11-26	0.06-0.2	0.14-0.18	5.1-7.3	High	High	Moderate	0.37	
	26-50	---	---	---	---	---	---	---	
DnB, DnC: Dennis	0-13	0.6-2.0	0.15-0.20	5.1-6.0	Low	Low	Moderate	0.43	5
	13-17	0.2-0.6	0.15-0.20	4.5-6.0	Moderate	Moderate	Moderate	0.37	
	17-78	0.06-0.2	0.15-0.20	5.1-8.4	High	High	Moderate	0.37	
EHC*:									
Enders	0-5	0.6-2.0	0.10-0.20	3.6-5.5	Low	Low	Moderate	0.37	3
	5-8	0.2-0.6	0.15-0.22	3.6-5.5	Low	Moderate	High	0.43	
	8-46	<0.06	0.12-0.18	3.6-5.5	High	High	High	0.37	
	46-62	---	---	---	---	---	---	---	
Hector	0-6	2.0-6.0	0.10-0.14	5.1-6.5	Low	Low	Moderate	0.17	1
	6-15	2.0-6.0	0.08-0.15	4.5-5.5	Low	Low	Moderate	0.17	
	15-16	---	---	---	---	---	---	---	
ErD*:									
Eram	0-8	0.2-0.6	0.15-0.19	5.6-6.5	Moderate	High	Moderate	0.43	3
	8-28	0.06-0.2	0.14-0.18	5.1-7.3	High	High	Moderate	0.37	
	28-34	---	---	---	---	---	---	---	
Radley	0-18	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	Low	Low	0.32	5
	18-60	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	Low	Low	0.32	
KaD: Kanima	0-4	0.6-6.0	0.02-0.15	5.6-8.4	Low	Moderate	Low	0.28	4
	4-70	0.6-6.0	0.02-0.12	5.6-8.4	Low	Moderate	Low	0.28	
LHC*:									
Liberal	0-7	0.6-2.0	0.20-0.24	4.5-6.0	Low	Moderate	Moderate	0.37	3
	7-12	0.2-0.6	0.18-0.20	3.6-6.0	Moderate	Moderate	High	0.37	
	12-28	0.06-0.2	0.11-0.20	4.5-6.5	High	High	Moderate	0.37	
	28-45	0.06-0.2	0.08-0.12	4.5-7.8	High	High	Moderate	0.37	
	45-60	---	---	---	---	---	---	---	
Hector	0-6	2.0-6.0	0.10-0.14	5.1-6.5	Low	Low	Moderate	0.17	1
	6-14	2.0-6.0	0.08-0.15	4.5-5.5	Low	Low	Moderate	0.17	
	14-16	---	---	---	---	---	---	---	

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea- bility	Available water capacity	Soil reaction	Shrink- swell potential	Risk of corrosion		Erosion factors	
						Uncoated steel	Concrete	K	T
	In	In/hr	In/in	pH					
Ma----------------- Mason	0-18	0.6-2.0	0.16-0.20	5.1-7.3	Low-------	Low-----------	Moderate-------	0.37	5
	18-64	0.2-0.6	0.16-0.20	4.5-7.8	Moderate	Moderate------	Moderate-------	0.37	
NoB---------------- Nowata	0-12	0.6-2.0	0.15-0.22	5.6-6.5	Low-------	Low-----------	Low------------	0.37	2
	12-18	0.6-2.0	0.11-0.16	5.6-6.5	Low-------	Moderate------	Moderate-------	0.37	
	18-36	0.2-0.6	0.08-0.12	5.6-7.3	Moderate	Moderate------	Moderate-------	0.32	
	36-38	---	---	---	----------	-------------	--------------	---	
Ow*. Oil-waste land									
OkA---------------- Okemah	0-18	0.2-2.0	0.16-0.20	5.6-7.3	Low-------	Moderate------	Moderate-------	0.43	5
	18-56	0.06-0.2	0.15-0.19	5.6-7.8	High------	High----------	Low------------	0.43	
	56-72	0.06-0.2	0.15-0.19	6.6-8.4	High------	High----------	Low------------	0.37	
Os----------------- Osage	0-18	<0.06	0.12-0.14	5.1-7.3	Very high	High----------	Moderate-------	---	---
	18-76	<0.06	0.08-0.12	5.6-7.8	Very high	High----------	Moderate-------	---	
PaA, PaB----------- Parsons	0-15	0.6-2.0	0.16-0.24	5.1-6.5	Low-------	High----------	Moderate-------	0.49	4
	15-74	<0.6	0.14-0.22	5.1-7.8	High------	High----------	Moderate-------	0.43	
Pt*. Pits									
Ra, RD*------------ Radley	0-18	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	Low-----------	Low------------	0.32	5
	18-64	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	Low-----------	Low------------	0.32	
ReB---------------- Riverton	0-9	0.6-2.0	0.12-0.20	5.1-6.5	Low-------	Moderate------	Moderate-------	0.37	3
	9-15	0.6-2.0	0.12-0.18	4.5-6.0	Low-------	Moderate------	Moderate-------	0.32	
	15-55	0.6-2.0	0.03-0.11	4.5-6.0	Low-------	Moderate------	Moderate-------	0.24	
	55-80	0.6-2.0	0.03-0.11	4.5-5.5	Low-------	Moderate------	Moderate-------	0.24	
ScB*: Shidler-----------	0-13	0.6-2.0	0.16-0.24	5.6-8.4	Low-------	Moderate------	Low------------	0.37	1
	13-15	---	---	---	----------	-------------	--------------	---	
Claremore---------	0-8	0.6-2.0	0.16-0.24	5.6-6.5	Low-------	Moderate------	Moderate-------	0.37	2
	8-12	0.6-2.0	0.16-0.22	5.6-6.5	Moderate	Moderate------	Moderate-------	0.37	
	12-18	0.6-2.0	0.16-0.20	5.6-7.3	Moderate	Moderate------	Moderate-------	0.32	
	18-20	---	---	---	----------	-------------	--------------	---	
SkD*: Shidler-----------	0-15	0.6-2.0	0.12-0.22	5.6-8.4	Low-------	Moderate------	Low------------	0.32	1
	15-17	---	---	---	----------	-------------	--------------	---	
Kiti--------------	0-13	0.6-2.0	0.07-0.11	6.6-8.4	Moderate	Moderate------	Low------------	0.28	1
	13-15	---	---	---	----------	-------------	--------------	---	
Limestone outcrop.									
SuC---------------- Summit	0-11	0.2-0.6	0.16-0.20	5.6-7.3	Moderate	High----------	Low------------	0.37	4
	11-18	0.2-0.6	0.10-0.18	5.6-7.3	High------	High----------	Low------------	0.37	
	18-80	0.06-0.2	0.10-0.18	5.6-8.4	High------	High----------	Low------------	0.32	
Wa----------------- Wynona	0-20	0.2-0.6	0.18-0.22	5.1-6.5	Moderate	High----------	Moderate-------	0.37	5
	20-65	0.06-0.2	0.14-0.20	5.1-6.0	Moderate	High----------	Moderate-------	0.37	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Flooding			High water table			Bedrock	
	Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
				Ft			In	
AeB: Apperson	None	---	---	1.5-2.0	Perched	Dec-Apr	40-60	Hard
CaB: Catoosa	None	---	---	>6.0	---	---	20-40	Hard
CbB*:								
Coweta	None	---	---	>6.0	---	---	10-20	Rippable
Bates	None	---	---	>6.0	---	---	20-40	Rippable
CeC*:								
Coweta	None	---	---	>6.0	---	---	10-20	Rippable
Eram	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Rippable
DnB, DnC: Dennis	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---
EHC*:								
Enders	None	---	---	>6.0	---	---	40-60	Rippable
Hector	None	---	---	>6.0	---	---	10-20	Hard
ErD*:								
Eram	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Rippable
Radley	Common	Very brief	Dec-Jul	>6.0	---	---	>60	---
KaD: Kanima	None	---	---	>6.0	---	---	>60	---
LHC*:								
Liberal	None	---	---	2.0-3.0	Perched	Nov-Mar	40-60	Rippable
Hector	None	---	---	>6.0	---	---	10-20	Hard
Ma: Mason	Rare	Very brief	Dec-Apr	>6.0	---	---	>60	---
NoB: Nowata	None	---	---	>6.0	---	---	20-40	Hard
Ow*. Oil-waste land								
OkA: Okemah	None	---	---	2.0-3.0	Perched	Mar-Jun	>60	---
Os: Osage	Common	Brief	Nov-May	0-1.0	Perched	Nov-May	>60	---
PaA, PaB: Parsons	None	---	---	0.5-1.5	Perched	Dec-Apr	>60	---
Pt*. Pits								
Ra, RD*: Radley	Common	Very brief	Dec-Jul	>6.0	---	---	>60	---

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Flooding			High water table			Bedrock	
	Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
				Ft			In	
ReB: Riverton	None	---	---	>6.0	---	---	>60	---
ScB*:								
Shidler	None	---	---	>6.0	---	---	4-20	Hard
Claremore	None	---	---	>6.0	---	---	10-20	Hard
SkD*:								
Shidler	None	---	---	>6.0	---	---	4-20	Hard
Kiti	None	---	---	>6.0	---	---	4-20	Hard
Limestone outcrop.								
SuC: Summit	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---
Wa: Wynona	Occasional	Very brief	Jan-Jul	0-2.0	Perched	Nov-Apr	>60	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Apperson	Fine, montmorillonitic, thermic Vertic Argiudolls
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Catoosa	Fine-silty, mixed, thermic Typic Argiudolls
*Claremore	Loamy, mixed, thermic Lithic Argiudolls
Coweta	Loamy, siliceous, thermic, shallow Typic Hapludolls
Dennis	Fine, mixed, thermic Aquic Paleudolls
Enders	Clayey, mixed, thermic Typic Hapludults
Eram	Fine, mixed, thermic Aquic Argiudolls
Hector	Loamy, siliceous, thermic Lithic Dystrochrepts
Kanima	Loamy-skeletal, mixed, nonacid, thermic Udalfic Arents
Kiti	Loamy-skeletal, mixed, thermic Lithic Haplustolls
Liberal	Fine, mixed, thermic Aquollic Hapludalfs
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Nowata	Loamy-skeletal, mixed, thermic Typic Argiudolls
Okemah	Fine, mixed, thermic Aquic Paleudolls
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Parsons	Fine, mixed, thermic Mollic Albaqualfs
Radley	Fine-silty, mixed, thermic Fluventic Hapludolls
Riverton	Loamy-skeletal, mixed, thermic Mollic Paleudalfs
Shidler	Loamy, mixed, thermic Lithic Haplustolls
Summit	Fine, montmorillonitic, thermic Vertic Argiudolls
Wynona	Fine-silty, mixed, thermic Cumulic Haplaquolls

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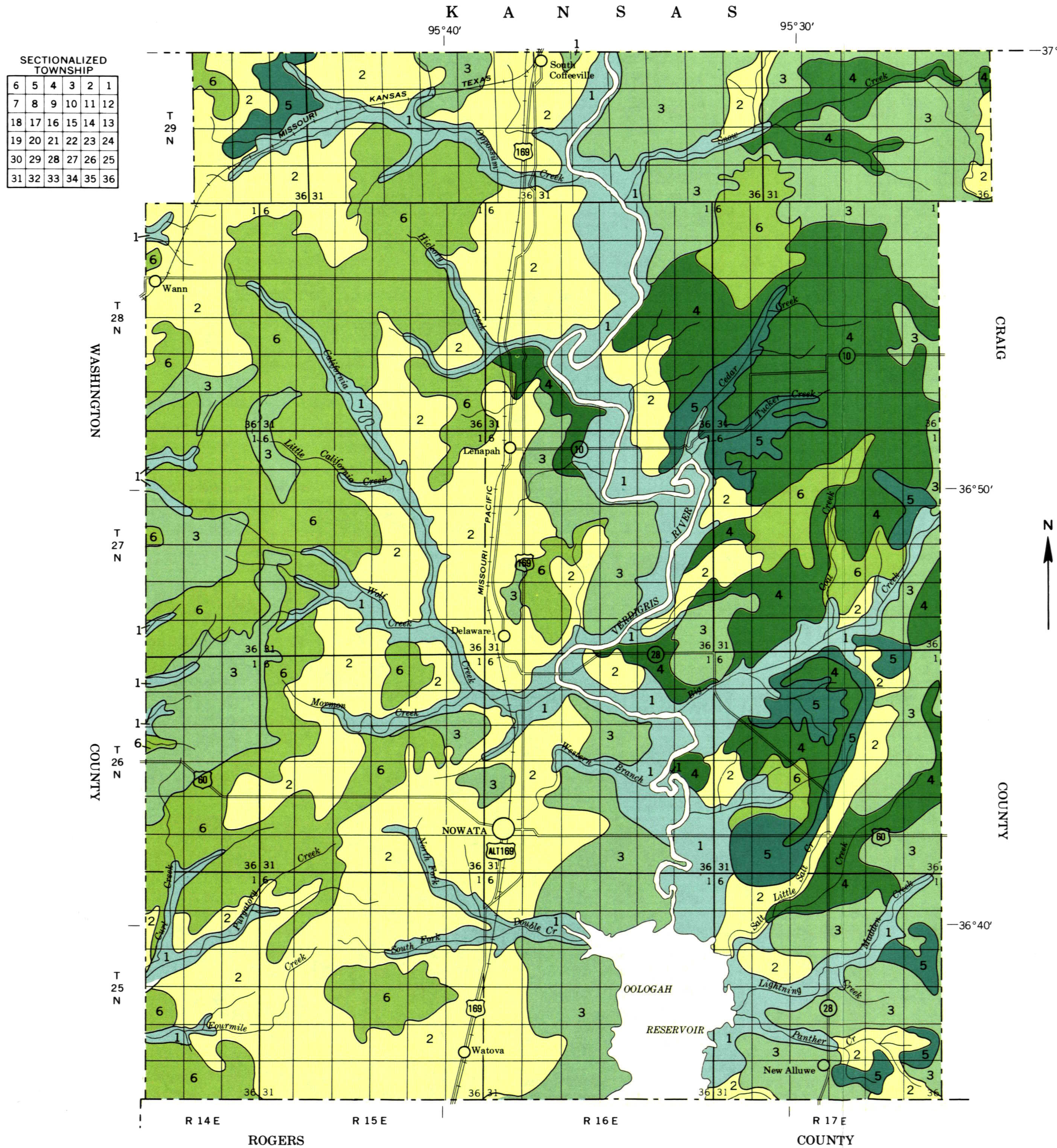


LEGEND

1	RADLEY-WYNONA-MASON: Deep, nearly level, moderately well drained and somewhat poorly drained loamy soils that have a loamy or clayey subsoil; on flood plains
2	DENNIS-PARSONS-OKEMAH: Deep, nearly level through gently sloping, moderately well drained and somewhat poorly drained loamy soils that have a clayey or loamy subsoil; on uplands
3	APPERSON-CATOOSA-SUMMIT: Deep and moderately deep, very gently sloping and gently sloping, moderately well drained and well drained loamy soils that have a clayey or loamy subsoil; on uplands
4	SHIDLER-CLAREMORE-KITI: Shallow, very gently sloping through sloping, well drained loamy soils that have a loamy subsoil; on uplands
5	ENDERS-HECTOR-LIBERAL: Shallow and deep, sloping, well drained and moderately well drained loamy soils that have a loamy or clayey subsoil; on uplands
6	COWETA-BATES-ERAM: Shallow and moderately deep, very gently sloping through moderately steep, somewhat excessively drained through moderately well drained loamy soils that have a loamy or clayey subsoil, on uplands

Compiled 1978

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

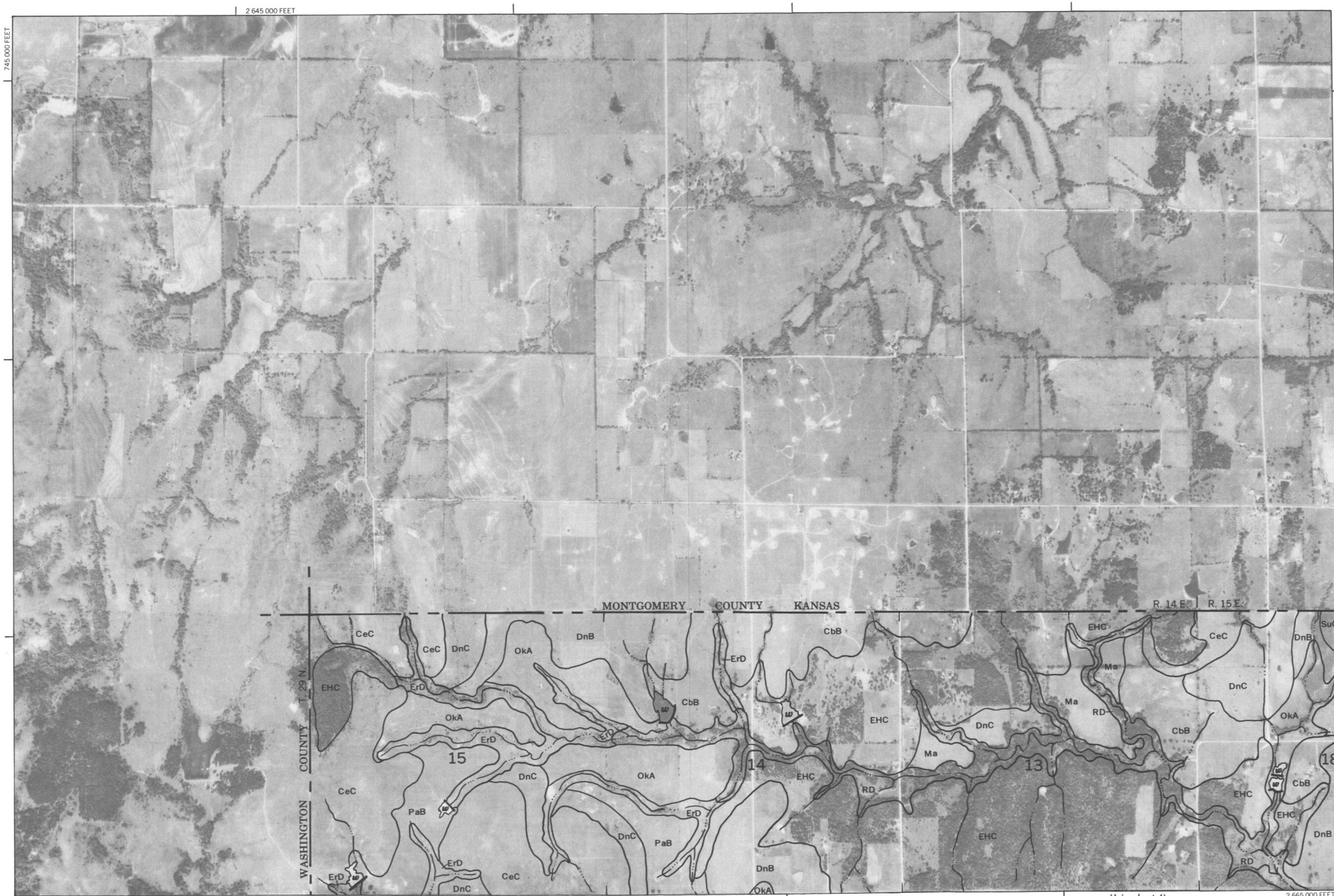
GENERAL SOIL MAP

NOWATA COUNTY, OKLAHOMA

Scale 1:190,080

1 0 1 2 3 4 Miles

NOWATA COUNTY, OKLAHOMA — SHEET NUMBER 1



1

N

Scale 1:20000

1 Mile
5000 Feet
0 ¼ ½ ¾ 1
0 1000 2000 3000 4000 5000

NOWATA COUNTY, OKLAHOMA NO. 1

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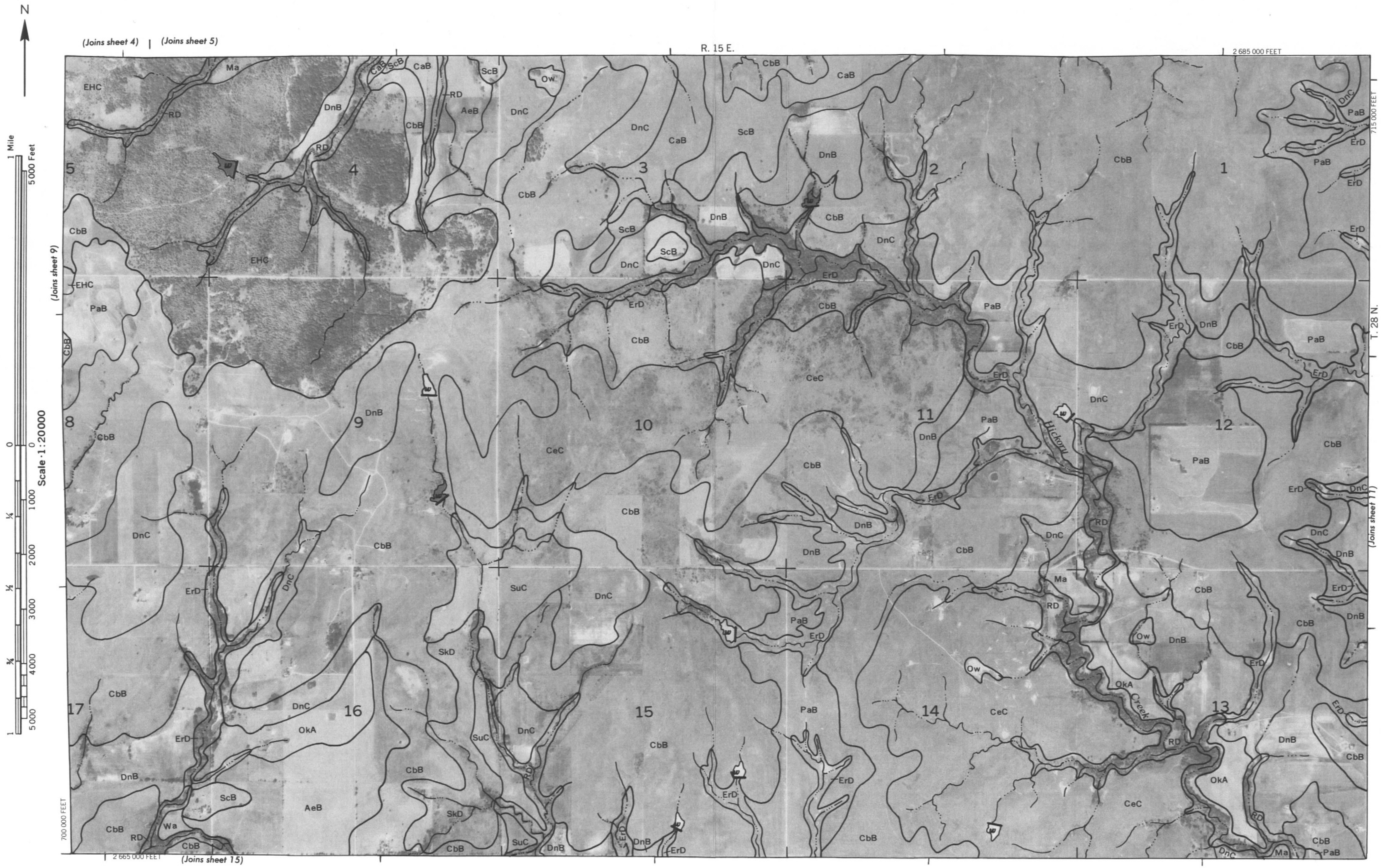
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 4)
(Joins sheet 5)
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 15)
R. 15 E.
T. 28 N.
2 685 000 FEET
715 000 FEET
700 000 FEET
2 665 000 FEET
Hickory
Creek
EHC
Ma
RD
DnB
CaB
ScB
AeB
DnC
Ow
CbB
PaB
ErD
CeC
SuC
SkD
OkA
Wa

NOWATA COUNTY, OKLAHOMA — SHEET NUMBER 11

NOWATA COUNTY, OKLAHOMA NO. 11

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NOWATA COUNTY, OKLAHOMA NO. 12

NOWATA COUNTY, OKLAHOMA NO. 13

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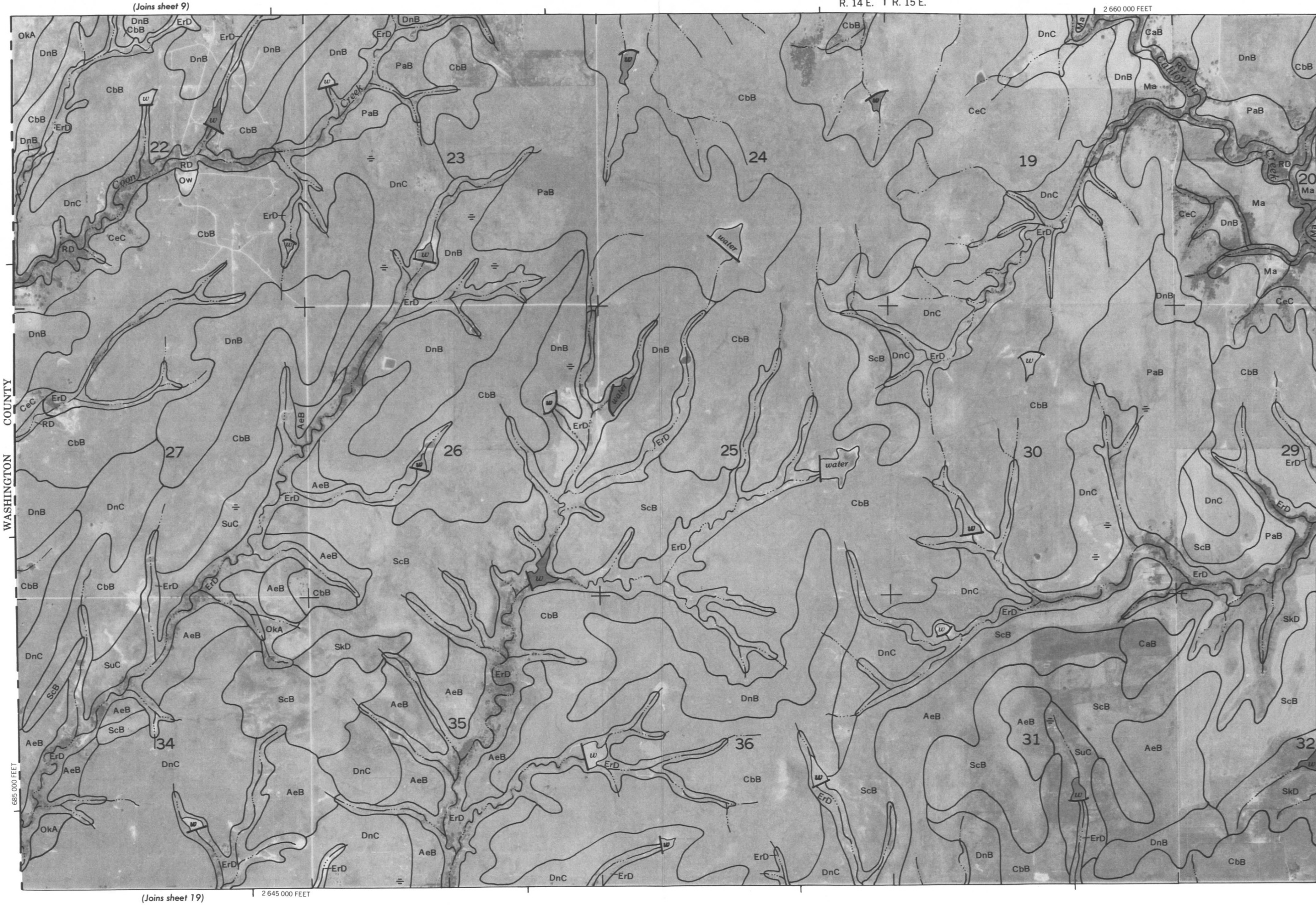
14

N



1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1

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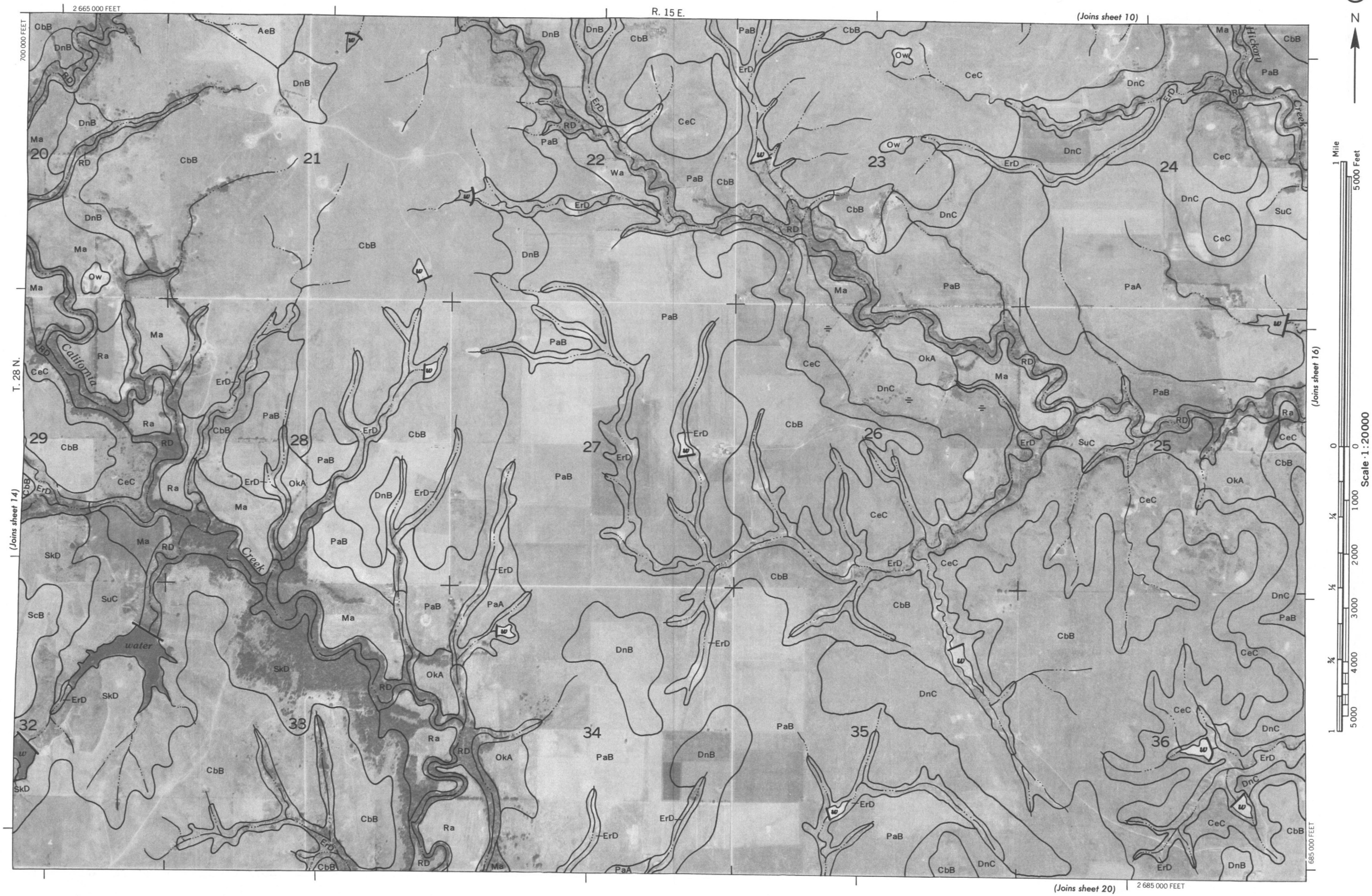
NOWATA COUNTY, OKLAHOMA NO. 14



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N

1 Mile

5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1

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NOWATA COUNTY, OKLAHOMA NO. 17

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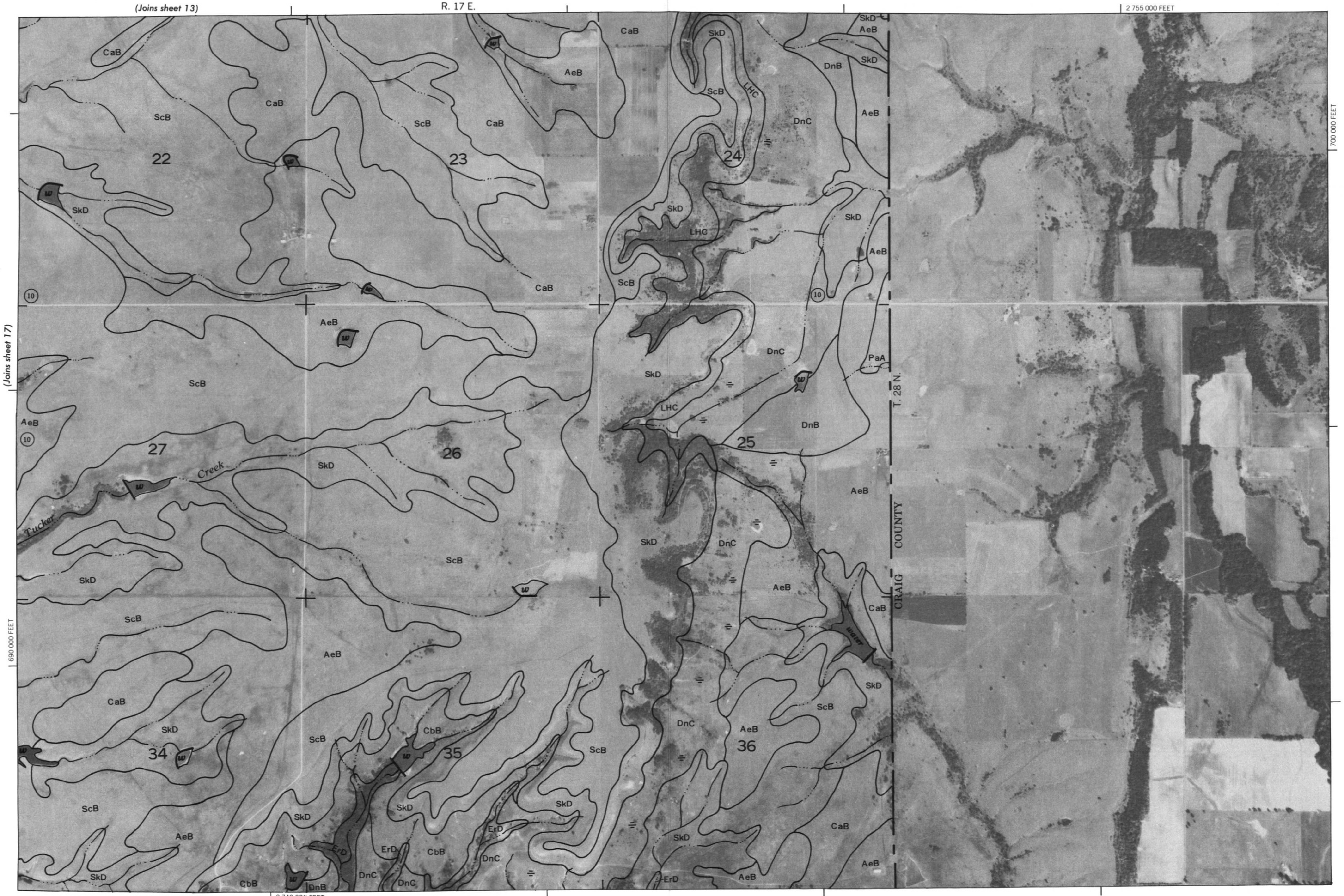
N

1 Mile 5000 Feet

Scale 1:20000

0 1000 2000 3000 4000 5000

0 ¼ ½ ¾ 1



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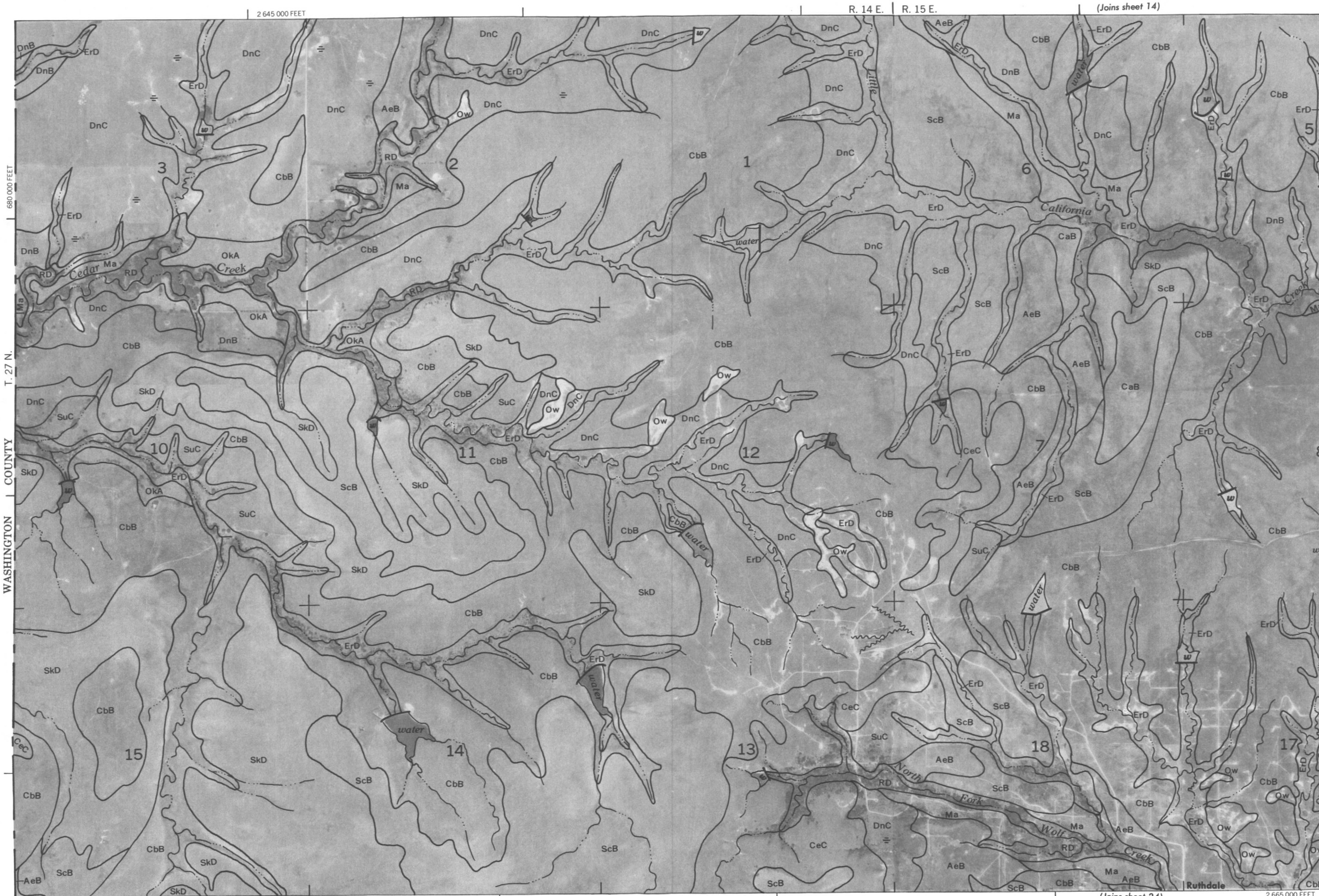
19



N

1 Mile
5000 Feet
Scale 1:20000

NOWATA COUNTY, OKLAHOMA NO. 19

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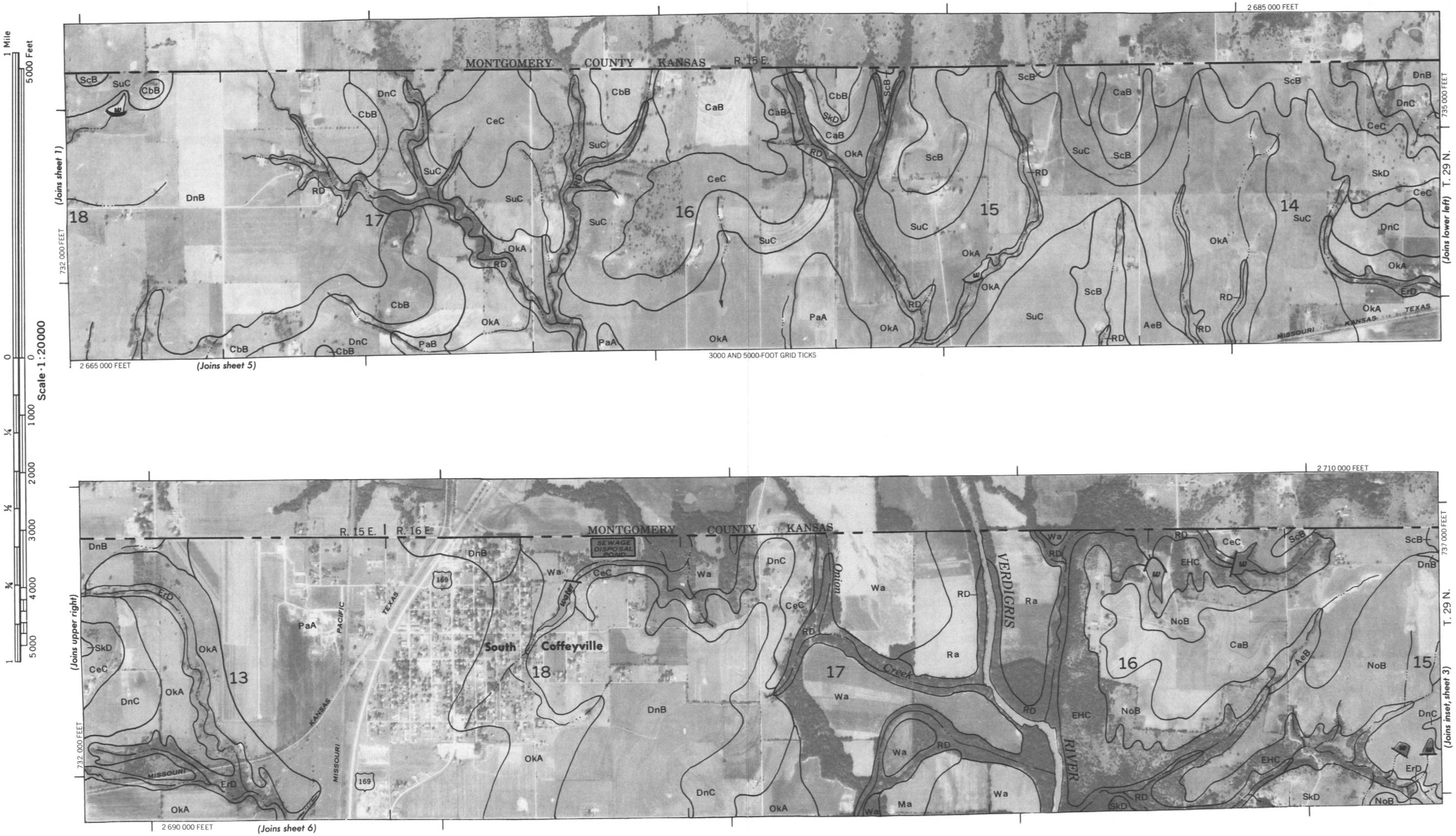
NOWATA COUNTY, OKLAHOMA — SHEET NUMBER 2



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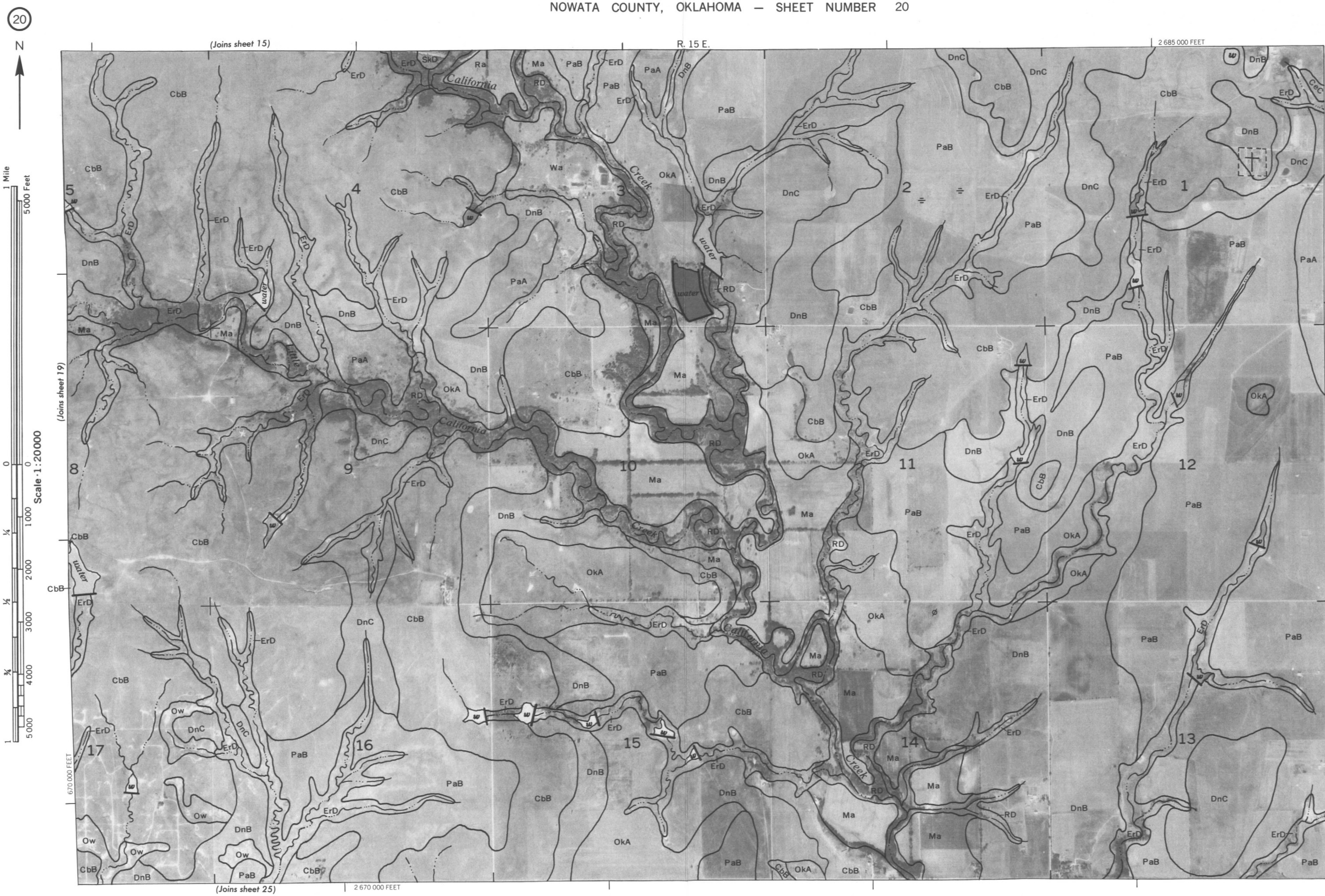

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NOWATA COUNTY, OKLAHOMA NO. 20

NOWATA COUNTY, OKLAHOMA NO. 21

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NOWATA COUNTY, OKLAHOMA — SHEET NUMBER 22

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NOWATA COUNTY, OKLAHOMA NO. 23

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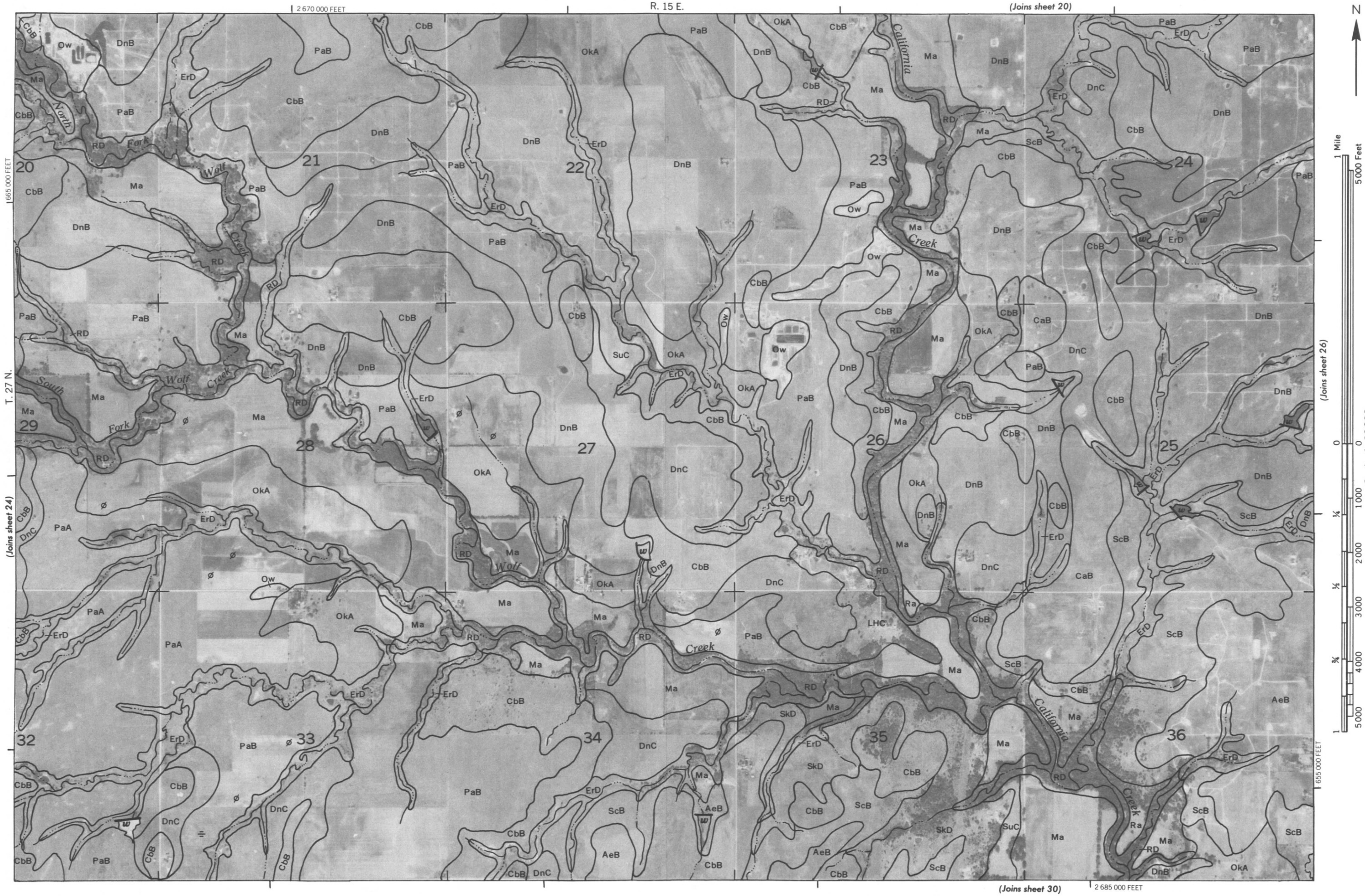
NOWATA COUNTY, OKLAHOMA NO. 24



NOWATA COUNTY, OKLAHOMA NO. 25

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NOWATA COUNTY, OKLAHOMA NO. 27

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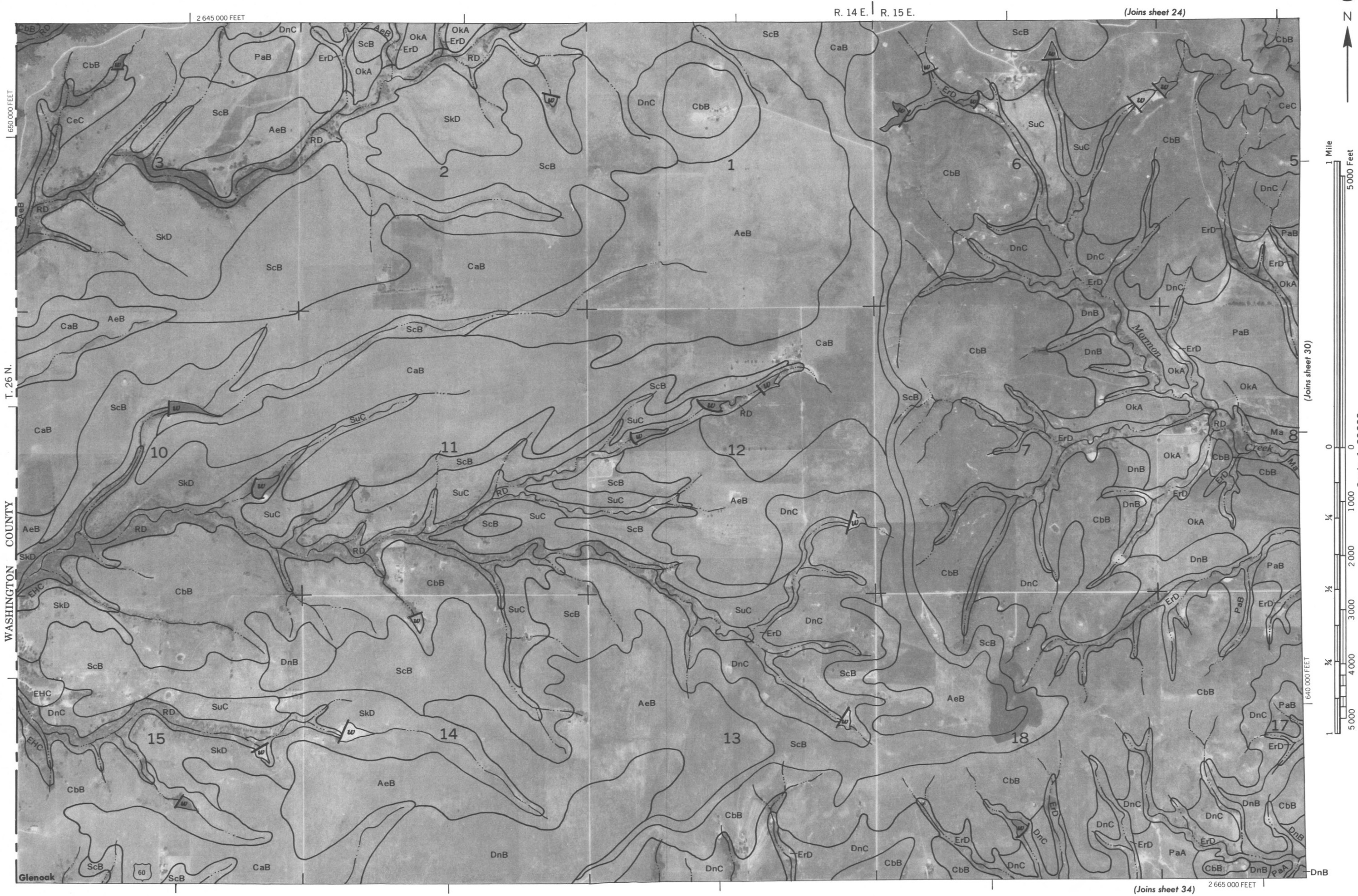
NOWATA COUNTY, OKLAHOMA NO. 28

29



NOWATA COUNTY, OKLAHOMA NO. 29

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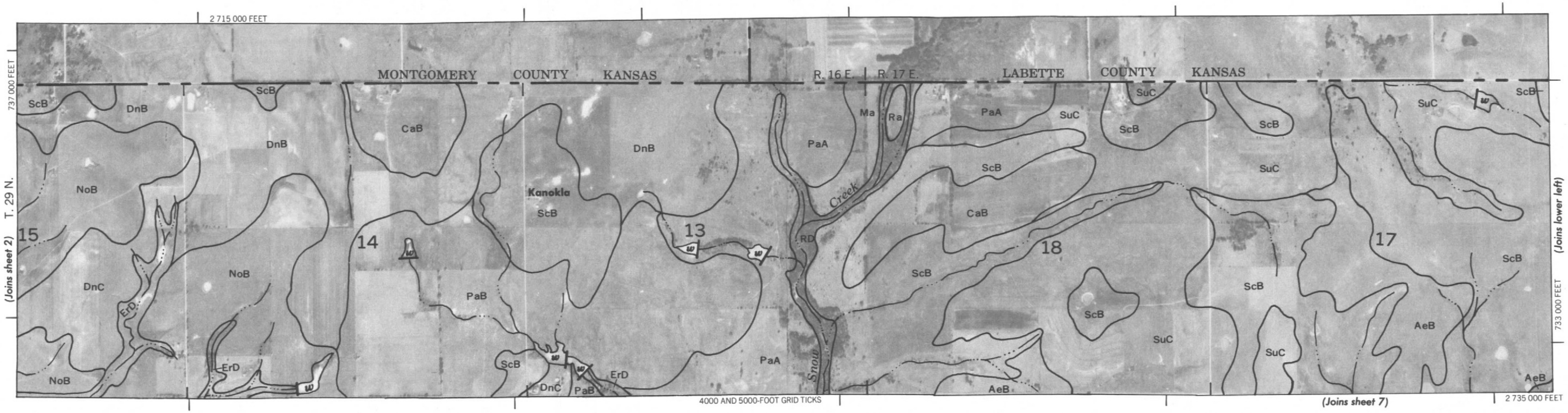

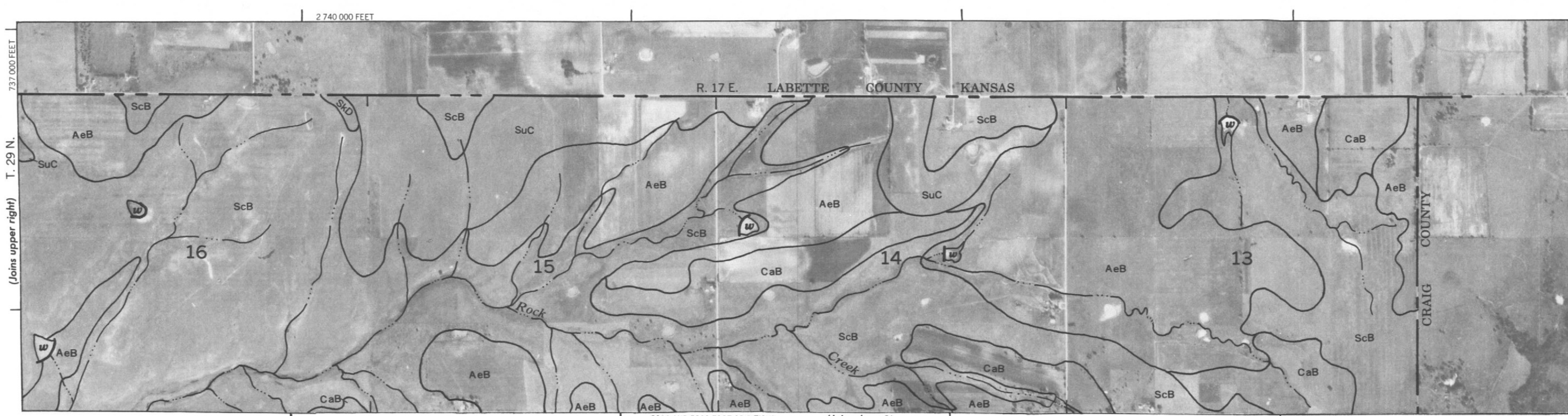

1 Mile
5000 Feet
Scale 1:20000

NOWATA COUNTY, OKLAHOMA NO. 3

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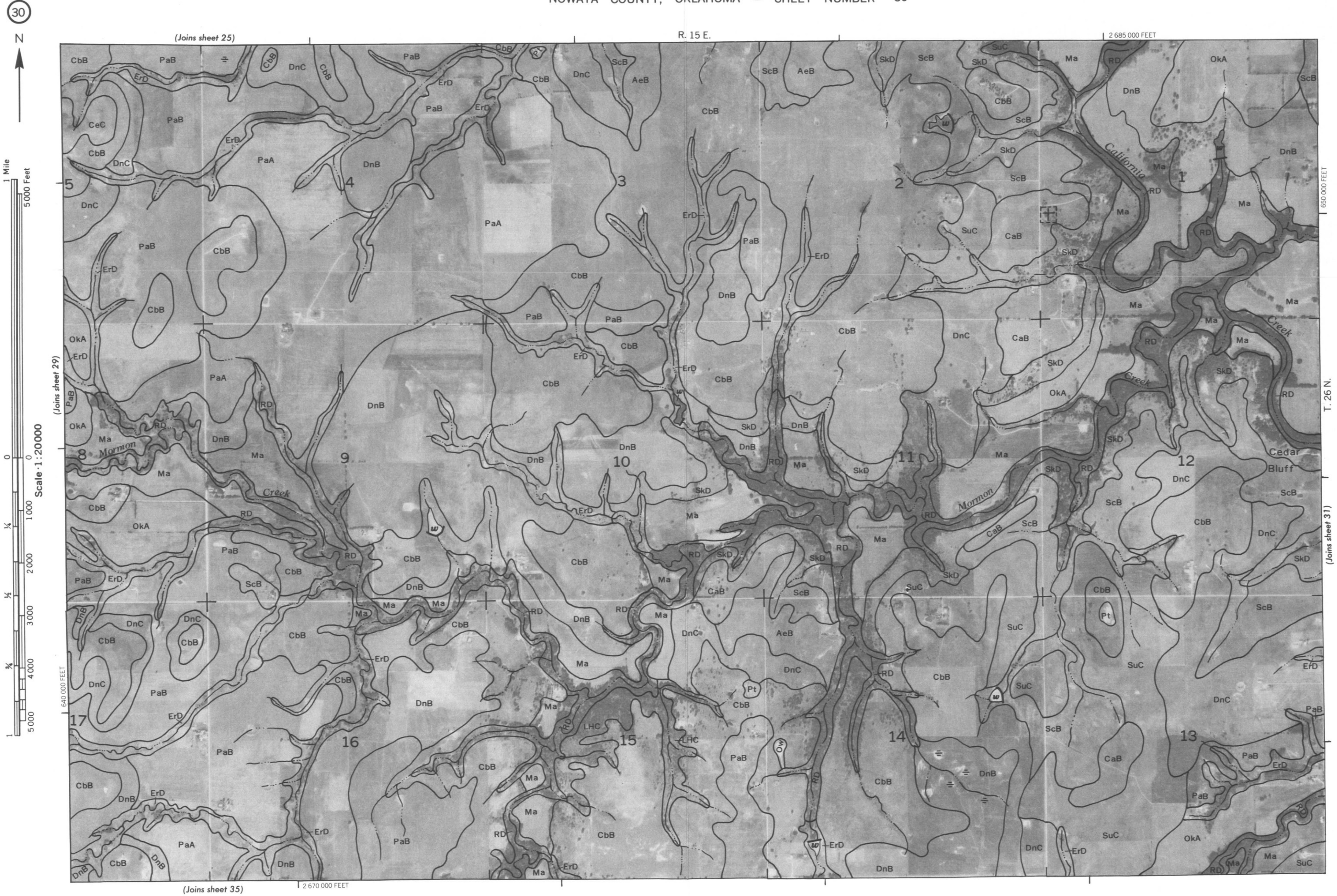

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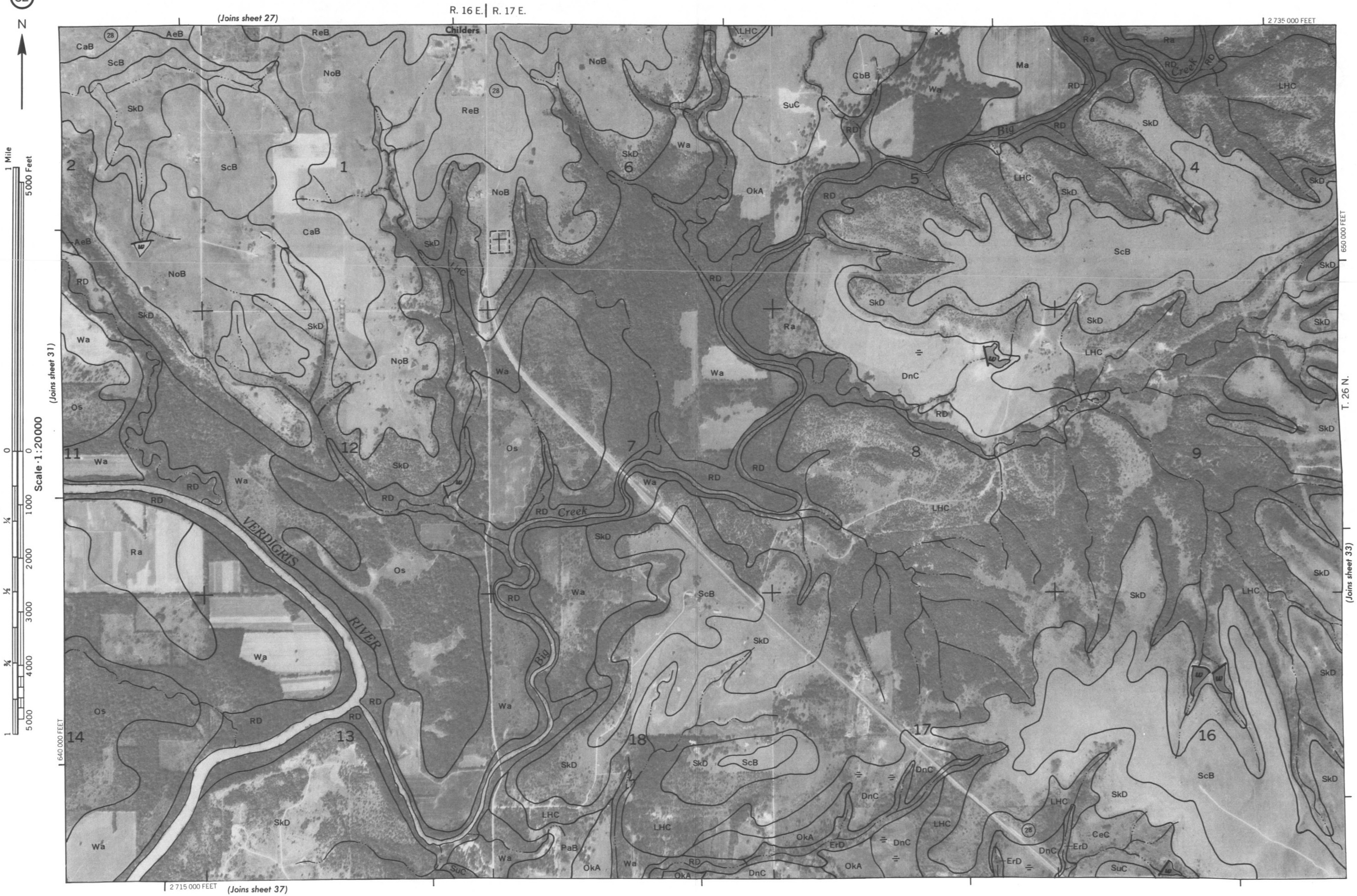
NOWATA COUNTY, OKLAHOMA NO. 31



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NOWATA COUNTY, OKLAHOMA NO. 32

33

NOWATA COUNTY, OKLAHOMA NO. 33

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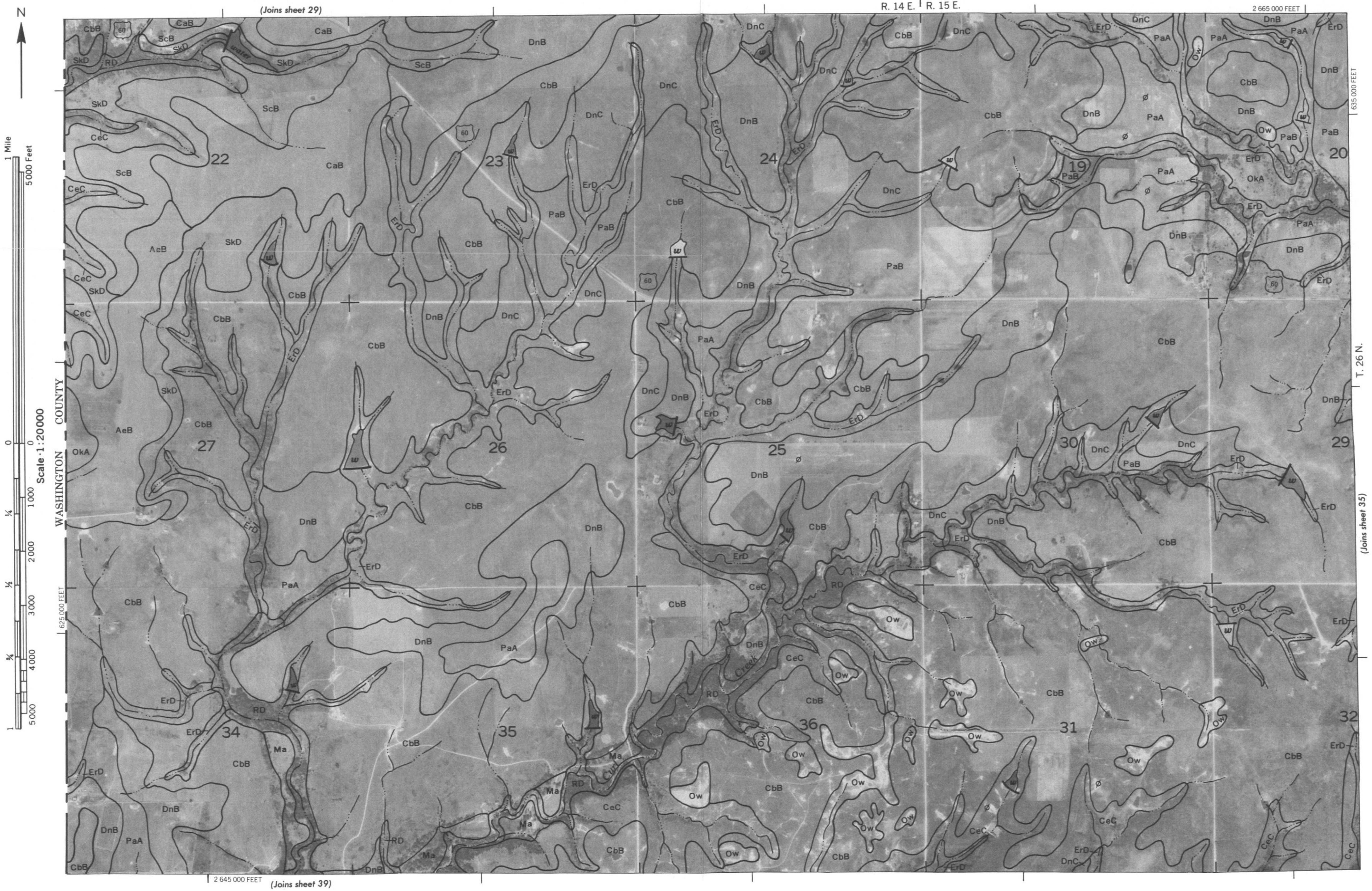

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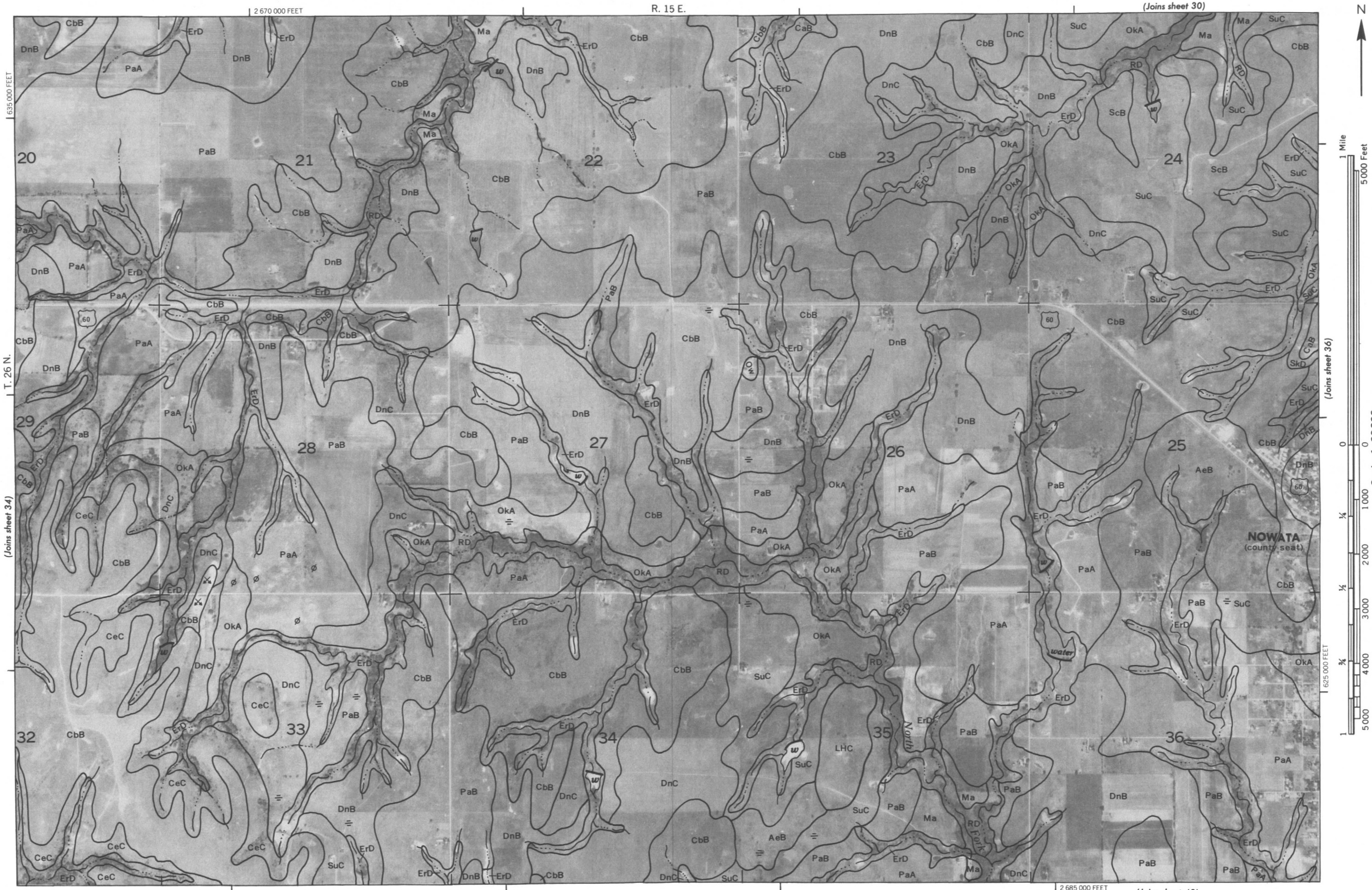

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NOWATA COUNTY, OKLAHOMA NO. 37

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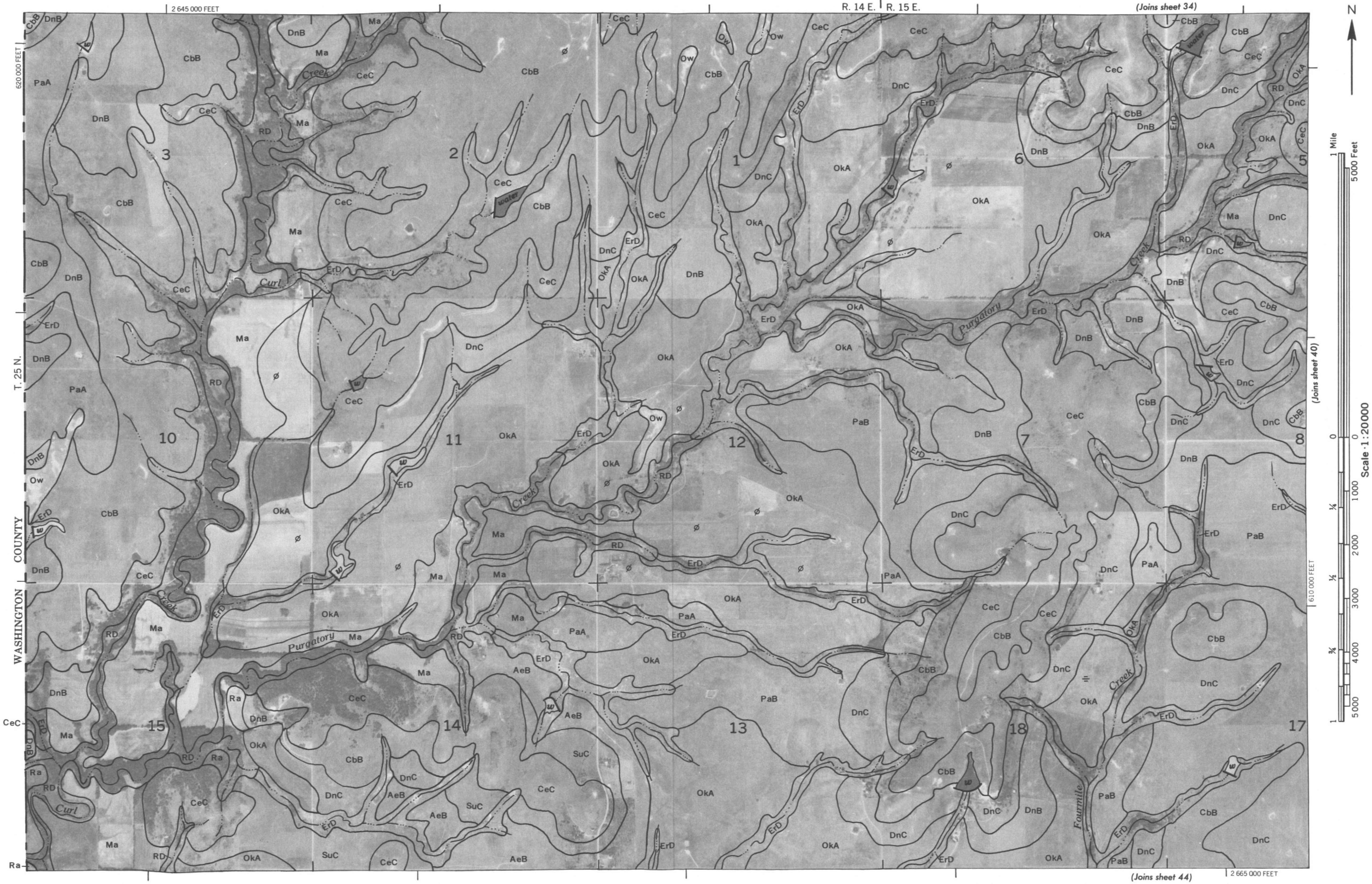

NOWATA COUNTY, OKLAHOMA NO. 39

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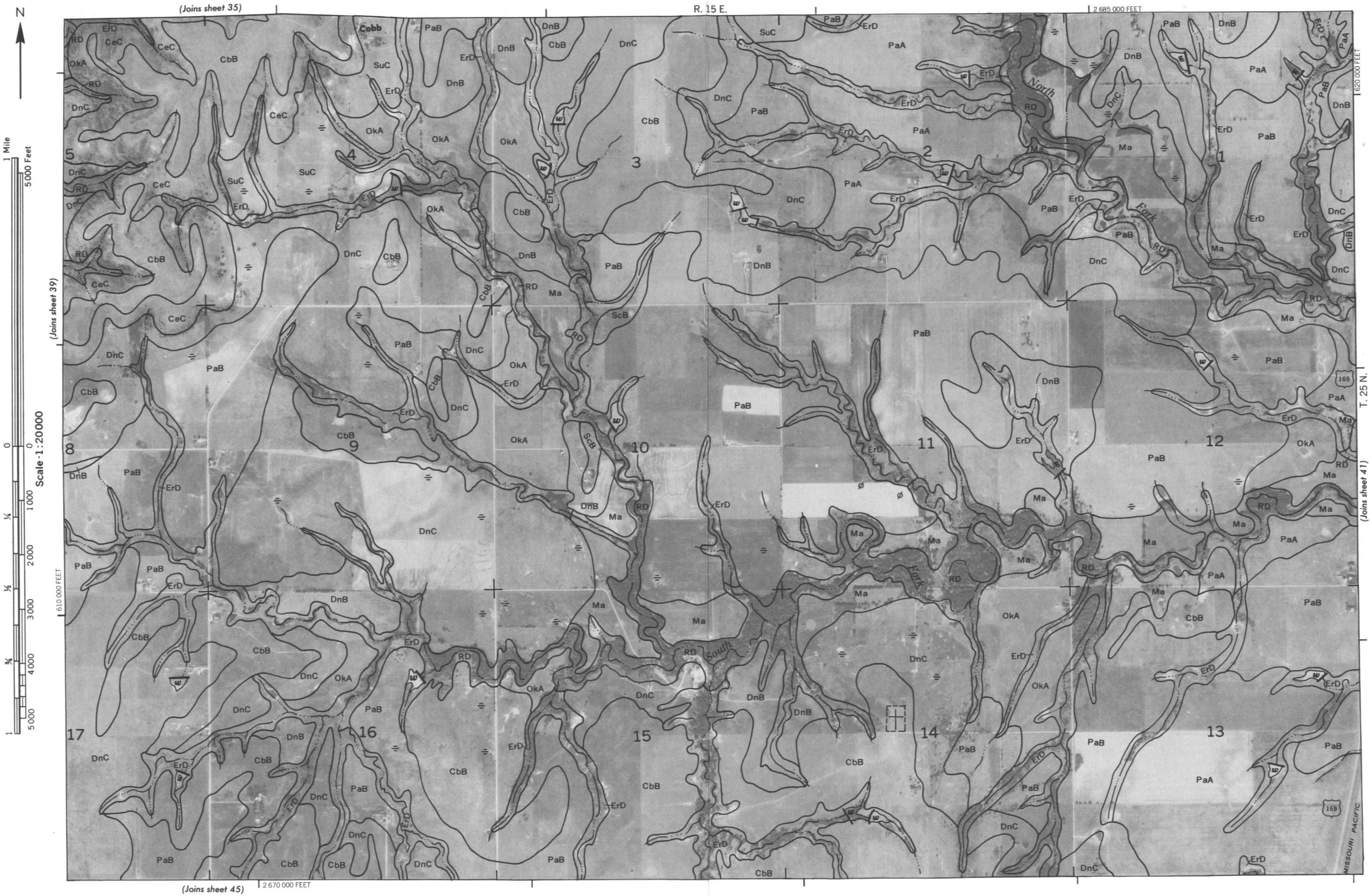

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NOWATA COUNTY, OKLAHOMA NO. 40

NOWATA COUNTY, OKLAHOMA NO. 41

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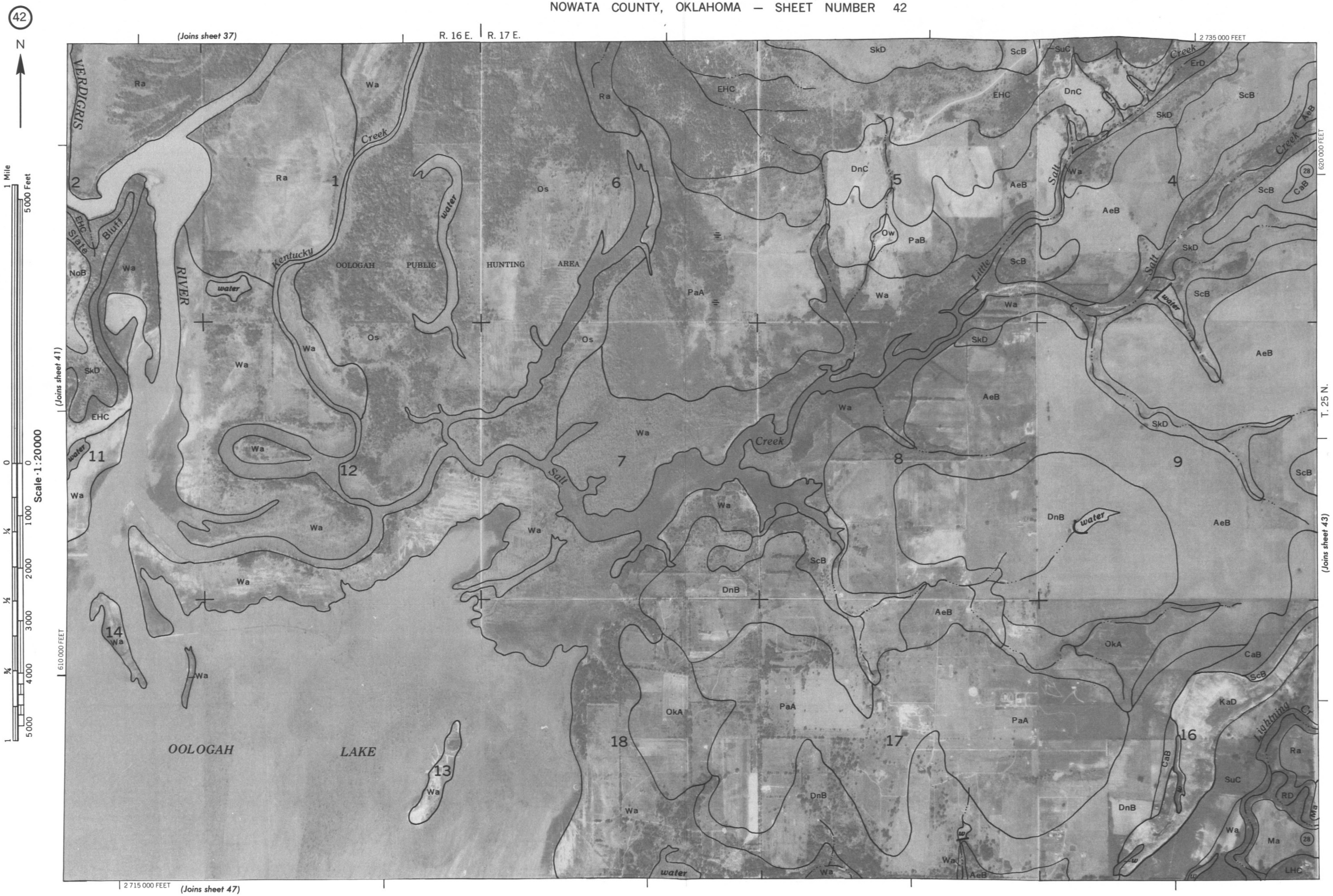

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NOWATA COUNTY, OKLAHOMA NO. 43

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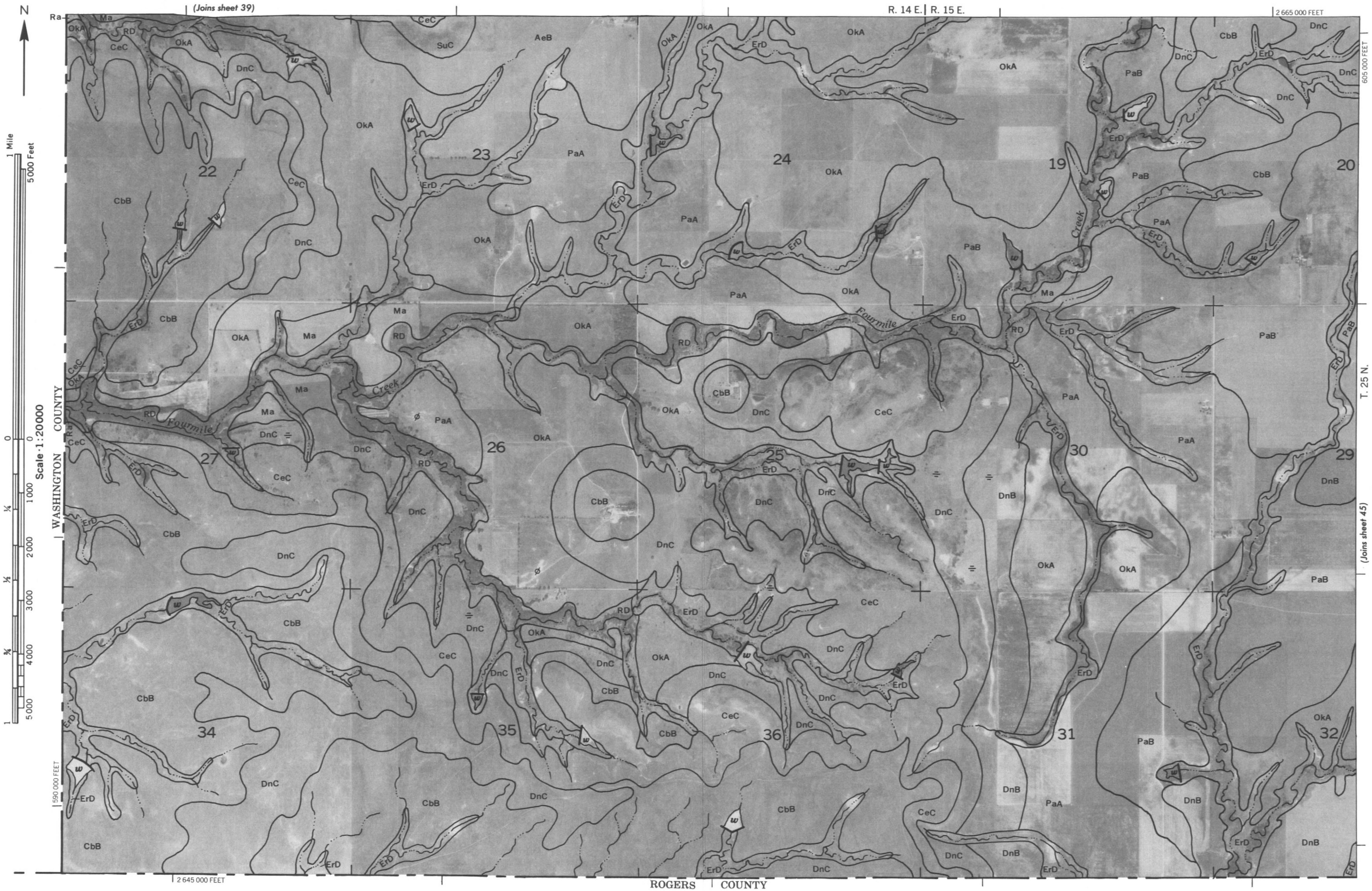

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NOWATA COUNTY, OKLAHOMA NO. 45

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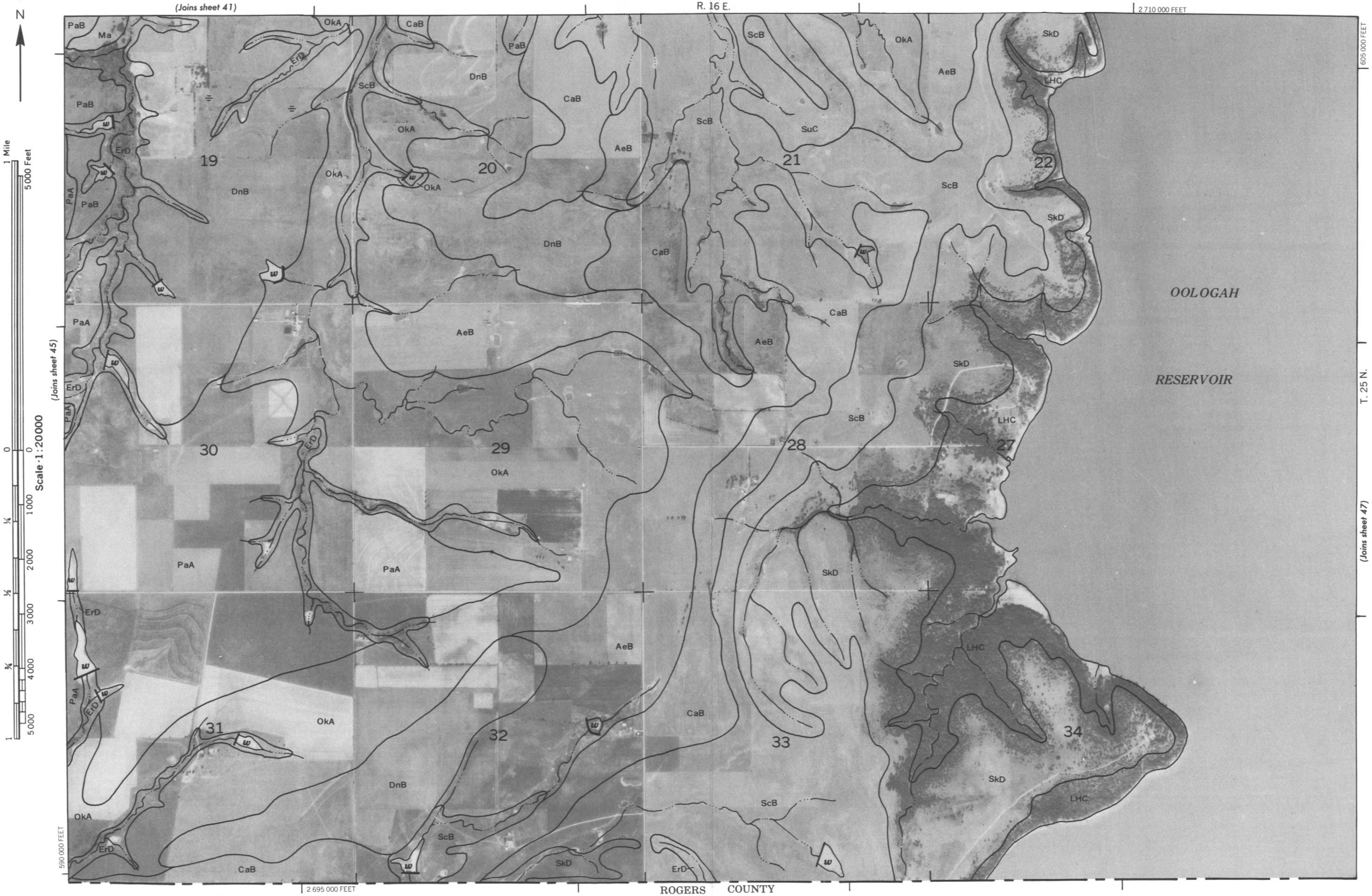

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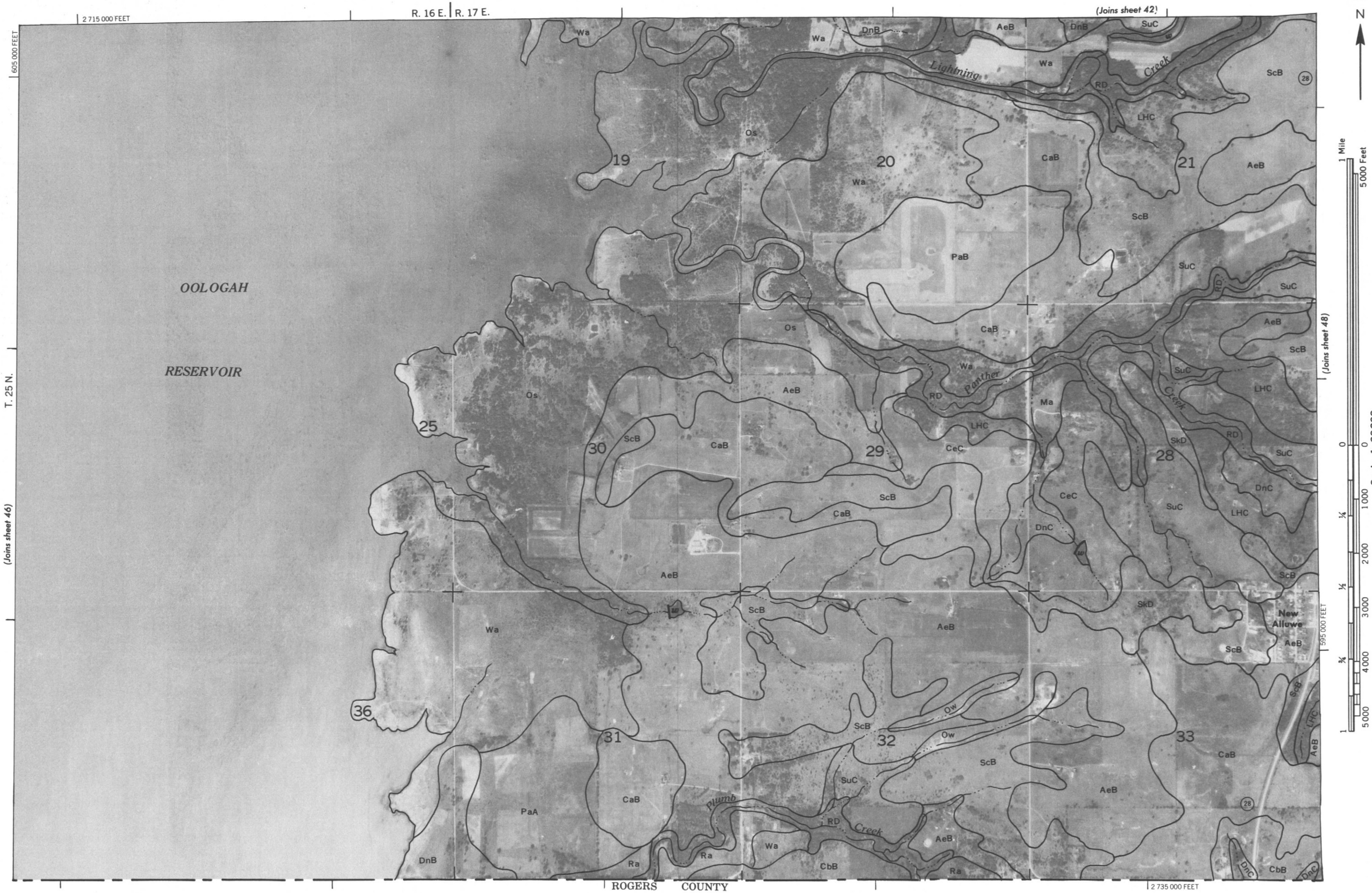

NOWATA COUNTY, OKLAHOMA NO. 47

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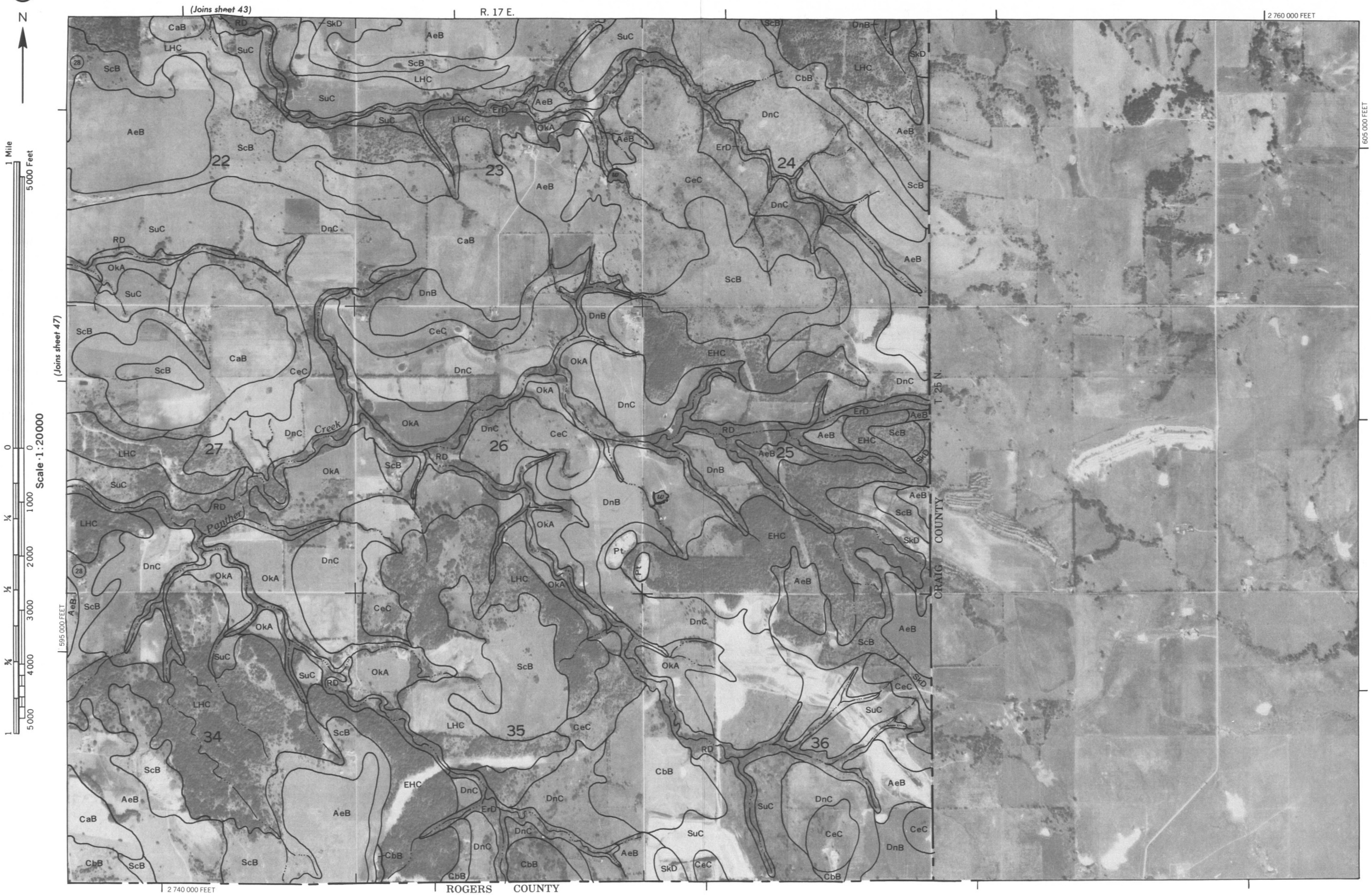
NOWATA COUNTY, OKLAHOMA — SHEET NUMBER 48



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NOWATA COUNTY, OKLAHOMA NO. 48

5

NOWATA COUNTY, OKLAHOMA NO. 5

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6

N

Scale 1:20000

1 Mile

5 000 Feet

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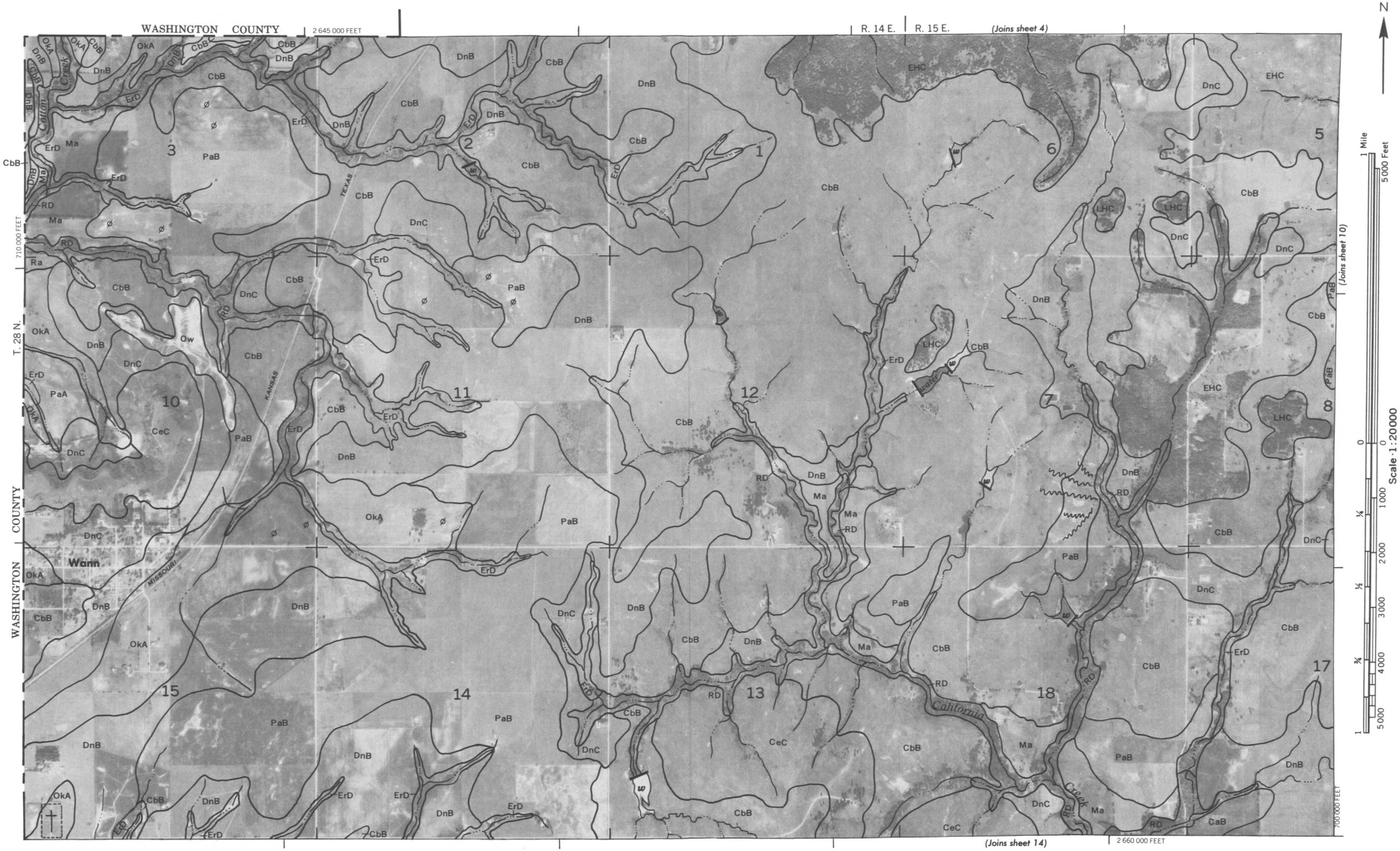
7


2 715 000 FEET
R. 16 E.
R. 17 E.
(Joins inset, sheet 3)
730 000 FEET
T. 29 N.
(Joins sheet 6)
(Joins sheet 8)
720 000 FEET
2 735 000 FEET
(Joins sheet 12)
(Joins sheet 13)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Snow Creek
Rock Creek
Crow Hollow
Creek
water
NoB
ErD
PaB
ScB
DnC
OkA
PaA
RD
Wa
AeB
SuC
CaB
CbB
SkD
Ma
SuC
CaB
CbB
SkD
PaB
ScB
DnC
OkA
AeB

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

NOWATA COUNTY, OKLAHOMA NO. 8



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